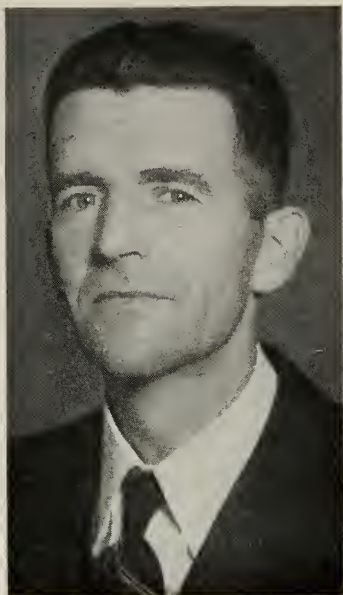


PROCEEDINGS

**Forty-Ninth Annual Convention
OF THE
American Railway
Bridge and Building Association
1942**



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R. E. Dove
President, 1942

Proceedings of the
Forty-Ninth Annual Convention

OF THE

American Railway
Bridge and Building
Association

Held at

CHICAGO, ILLINOIS

October 20-22, 1942

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Elinor V. Heffern, Secretary
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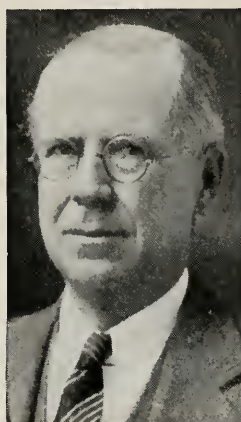
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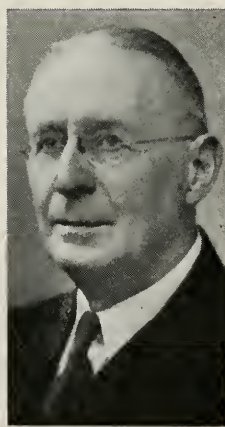
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SUBJECTS AND COMMITTEE PERSONNEL

1943 MEETING

(To be held at the Hotel Sherman, Chicago, October 15-17, 1943)

Salvaging Bridge, Building and Water Service Materials

H. W. Wuerth (chairman), div. engr., C. M. St. P. & P., Savanna, Ill.
E. H. Barnhart (vice-chairman), div. engr., B. & O., Garrett, Ind.
W. A. Huckstep (vice-chairman), gen. br. supv., M. P., St. Louis, Mo.
Maxfield Bear (vice-chairman), est., C. & N. W., Chicago.
John E. Bird, b. & b. insp., N. Y. C., Corning, N. Y.
R. W. Cook, gen. br. insp., Seaboard, Norfolk, Va.
J. B. Lodeski, asst. gen. br. insp., C. & N. W., Chicago.
G. L. Sitton, ch. engr., m. w. & str., Sou., Charlotte, N. C.
M. P. Walden, asst. supv., b. & b., L. & N., Evansville, Ind.
L. G. Byrd, supv. b. & b., M. P., Poplar Bluff, Mo.
R. H. Morrison, supt. b. & b., Bang. & Aroos., Houlton, Me.
Alfred G. Rose, sc. & br. insp., M. P., Osawatomie, Kan.

Men—How to Secure and Hold

M. D. Carothers (chairman), ch. engr., Alton, Chicago.
E. E. Tanner (vice-chairman), gen. supv. b. & b., N. Y. C., New York.
N. D. Howard (vice-chairman), managing editor, Ry. Engr. & Mtce., Chgo.
H. C. Crawford (vice-chairman), b. & b. supv., S. P., Dunsmuir, Cal.
Abraham Frazin, engr. drftsmn., C. & N. W., Chicago.
G. H. Holmes, supv. b. & b., M. P., Falls City, Nebr.
A. M. Knowles, engr. str., Erie, Cleveland, Ohio.
P. L. Koehler, div. engr., C. & O., Ashland, Ky.
M. Meyer, supv. b. & b., C. & W. I., Chicago.
Dee Worlow, b. & b. fore., M. P., Kansas City, Mo.

Materials—Possibilities of Relief Through Substitutes

W. A. Sweet (chairman), gen. fore., b. & b., A. T. & S. F., Newton, Kan.
H. M. Church (vice-chairman), gen. supv. b. & b., C. & O., Richmond, Va.
W. L. Anderson (vice-chairman), off. engr., C. & N. W., Chicago.
L. E. Peyser (vice-chairman), asst. arch., S. P., San Francisco, Cal.
F. W. Dayton, arch. drftsmn., C. & N. W., Chicago.
H. M. Dick, mstr. carp., P. R. R., Toledo, Ohio.
A. G. Dorland, asst. engr., E. J. & E., Joliet, Ill.
A. W. Glander, ch. carp., C. M. St. P. & P., Mason City, Ia.
F. W. Hutcheson, asst. supv., b. & b., C. & O., Newport News, Va.
F. H. Masters, ch. engr., E. J. & E., Joliet, Ill.
B. M. Whitehouse, gen. br. insp., C. & N. W., Chicago.

The Cleaning of Pipe Lines—In Water Service

G. V. Coffey (chairman), asst. supv. b. & b., M. C., Jackson, Mich.
G. E. Martin (chairman), supt. w. s., I. C., Chicago.
J. P. Hanley, w. s. insp., I. C., Chicago.
L. R. Morgan, transitman, N. Y. C., Syracuse, N. Y.
S. E. Bateman, fore. w. s., M. P., Poplar Bluff, Mo.
R. T. Burns, supv. w. s., C. & N. W., Boone, Ia.
L. M. Firehammer, gen. supv. b. & b., Il. Term., Springfield, Ill.
A. P. Smith, fuel & water supv., M. P., San Antonio, Tex.
Garry Smith, fore. w. s., N. Y. C., Rochester, N. Y.

The Maintenance of Coaling and Sanding Plants to Meet Today's Exacting Requirements

- A. L. McCloy (chairman), supv. b. & b., P. M., Saginaw, Mich.
 B. F. Francis (vice-chairman), supv. b. & b., N. Y. C., Jersey Shore, Pa.
 P. L. Koehler (vice-chairman), div. engr., C. & O., Ashland, Ky.
 F. R. Spofford (vice-chairman), b. & b. supv., B. & M., Boston, Mass.
 L. Clapper, asst. ch. engr., D. M. & I., Duluth, Minn.
 D. W. Converse, asst. engr., A. C. & Y., Akron, Ohio.
 L. A. Cowser, w. insp., B. & O., Dayton, Ohio.
 V. E. Engman, ch. carp., C. M. St. P. & P., Savanna, Ill.
 W. K. Manning, gen. fore., Erie, Cleveland, Ohio.
 L. R. Thompson, supv. b. & b., M. & St. L., Oskaloosa, Ia.
 H. D. Tubbs, res. engr., P. M., Detroit, Mich.
 H. A. Wistrich, asst. ch. engr., L. V., Bethlehem, Pa.
 J. F. Zanolio, mstr. carp., D. & R. G. W., Grand Jct., Co'o.

Securing Maximum Utilization of Work Equipment

- D. T. Rintoul (chairman), gen. br. insp., S. P., San Francisco, Cal.
 H. I. Benjamin (vice-chairman), v.-chman. system comm. ins., S. P., San Francisco, Cal.
 W. F. Martens (vice-chairman), gen. fore. b. & b., A. T. & S. F., San Bernardino, Cal.
 H. M. Church (vice-chairman), gen. supv. b. & b., C. & O., Richmond, Va.
 F. E. Taggart, asst. engr., I. C., Chicago.
 F. G. Campbell, asst. ch. engr., E. J. & E., Joliet, Ill.
 B. J. Chamberlin, sc. supv., C. & E. I., Danville, Ill.
 John S. Vreeland, assoc. editor, Ry. Engr. & Mtce., Chicago.
 J. E. Hogan, asst. div. engr., C. & O., Hinton, Va.
 S. H. Knight, supv. wrk. eqpt., N. P., St. Paul, Minn.
 J. D. Holmes, supv. b. & b., N. Y. N. H. & H., New Haven, Conn.

Revising Working Practices to Eliminate Interference With Traffic

- L. R. Lamport (chairman), asst. to ch. engr., C. & N. W., Chicago.
 G. W. Benson (vice-chairman), supv. b. & b., C. of Ga., Macon, Ga.
 R. W. Cassidy, asst. cost engr., C. & O., Richmond, Va.
 A. B. Hillman, engr. m. of w., C. & W. I.—Belt Ry. of Chicago, Chicago.
 Howard C. Madson, designer, C. & N. W., Chicago.
 C. A. J. Richards, mstr. carp., P. R. R., Grand Rapids, Mich.
 A. C. Jones, b. & b. supv., Sou., Parrish, Ala.
 M. H. Dick, eastern editor, Ry. Engr. & Mtce., New York.
 R. C. Baker, b. & b. supv., C. & E. I., Danville, Ill.

Carrying Over Bridges and Trestles

- H. T. Livingston (chairman), engr. br., C. R. I. & P., Chicago.
 S. T. Corey (vice-chairman), off. engr., C. R. I. & P., Chicago.
 John S. Hancock (vice-chairman), br. engr., D. T. & I., Dearborn, Mich.
 A. E. Bechtelheimer, engr. of br., C. & N. W., Chicago.
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 F. W. Hillman, asst. engr. m., C. & N. W., Chicago.
 Carl Djuvik, supv. bldgs., Tenn. Cen., Nashville, Tenn.
 Leo D. Garis, asst. gen. br. insp., C. & N. W., Chicago.
 H. D. Curie, mstr. carp., B. & O., Garrett, Ind.
 H. W. Jenkins, supv. b. & b., N. Y. N. H. & H., Boston, Mass.
 J. L. Varker, b. & b. supv., D. & H., Carbondale, Pa.

In Memoriam - George W. Rear

1873



1942

George W. Rear

George W. Rear was born in the Province of Ontario, Canada, on June 13, 1873. He was the son of John and Mandilla (Hilborn) Rear. He married Madge Virginia Jackman on April 8, 1903. Of this union was born two children, Madge Dorothy and George W., Jr.

Mr. Rear attended Campbellford Collegiate Institute from 1886 to 1889. Upon leaving college in 1889, he entered railway service with the Midland Railway (now a part of the Canadian National), as a student in engineering, and in 1896 was made foreman of bridge construction on the Grand Trunk (now also a part of the Canadian National), and later served as chief clerk of maintenance in the office of superintendent. In July, 1901, he went with the Southern Pacific as foreman of steel bridge erection, and on April 1, 1902, he was appointed assistant bridge inspector. On August 15, 1905, Mr. Rear was promoted to general bridge inspector, and in March, 1922, he was appointed engineer of bridges, which position he held until his death on February 10, 1942.

Mr. Rear became a member of the American Railway Bridge and Building Association in 1904. Almost immediately he became active in the affairs of the association and was its twenty-fifth president in 1916. He was an energetic and valuable worker for nearly forty years, serving with distinction on many committees and in various offices. His interest and influence in the association never lagged during his long membership, his last contribution being on the occasion of the commemoration of the fiftieth anniversary of the association only a few months before his death. George Rear commanded the admiration, respect and friendship of all who knew him. In his passing, the association has lost a valued member, and his associates a loved and honored friend.

PROCEEDINGS

MINUTES AND ADDRESSES

OPENING SESSION

Tuesday, Oct. 20, 1942

The first session of the Forty-Ninth annual meeting of the American Railway Bridge and Building Association was called to order at 10:15 Tuesday morning, October 20, 1942, in the Crystal room of the Hotel Sherman, Chicago, by President, R. E. Dove.

President Dove: The Forty-Ninth annual meeting of the American Railway Bridge and Building Association will come to order. I am happy to welcome you all here today, but before we go into our association work, shall we rise while we ask Divine guidance in our deliberations. Reverend Fred Harrison, pastor of the Elmhurst Congregational Church, has accepted my invitation to give the invocation. (Reverend Harrison delivered the invocation, while those present stood with heads bowed.)

President Dove: Thank you, Reverend Harrison.

For the convenience of those using this volume, it is divided into two parts, one beginning with this page, presenting a running report of the convention, with suitable page references to the second part, which groups together the committee reports and various technical papers and addresses.

The man whom we invited to make the opening address at our annual meeting really needs no introduction to the members of our association. He has been with us many times in the past; has made forceful

opening addresses at our convention on previous occasions, the last time being in 1939. That man is C. E. Johnston, chairman of the Western Association of Railway Executives, and also associate director, Western Region of the Office of Defense Transportation. Mr. Johnston has never hesitated to tell us exactly what he has in his mind and does not pull his punches. He knows us well, having been a member of our organization for 31 years, and will address us in our own language on "The Problems That Confront Us In These Critical Days." It is a pleasure to present Mr. Johnston.

The Problems That Confront Us

By C. E. Johnston

Chairman, Western Association of Railway Executives, and Associate Director, Western Region, Office of Defense Transportation



C. E. Johnston

It is truly a privilege and a pleasure for me to be here today at the opening of your Annual meeting. I have been a member of this organization for a long time, and am particularly happy when in your company because your interests, your frankness and your sincerity appeal to me. I have addressed your meetings in the past; in fact, I have been pretty regular.

I am thoroughly sold on the truth of the statement that we live in the grandest country on earth, and I am certain you will all agree with this. I made such a statement to you three years ago, and make it again now. As a matter of fact, I can see no reason why I should not make it many, many times in the future.

Our forefathers fought for this great country and handed it down to us. We are now engaged in a life and death struggle to preserve this heritage. You need not ask whether we will be able to keep it. You know very well we will—at any cost.

At your meeting three years

ago, after the war had started in Europe, I made the following statement: "The railroads, at the moment, face a difficult situation, aggravated by the European war. The minds of our people are running toward national defense and preparedness, which automatically brings careful scrutiny of our railroad transportation system—the backbone of any scheme of effective national defense."

Also, and I further quote: "A national emergency, which I trust we shall never see, involves the movement of large bodies of men, quickly and safely. It involves the movement of large quantities of munitions and other implements of war; the movement of materials and supplies for our armed forces; all, in addition to the normal requirements of our people. Speed, reliability and adequacy of service are essential."

Are We Equal To The Task?

Then I said, "We, gentlemen, are the people who maintain and operate the railroads upon which our national defense depends in large part, so that the matter boils down to one question that we may well ask ourselves—are we equal to the task?"

I have been asked to speak to you this morning upon The Problems That Confront Us. This assignment, in itself, presents somewhat of a problem as to how and where to start, because our prob-

lems are many, varied and serious. But, representing the composite whole of these many different problems which we now face, there stands directly before us the greatest problem with which the people of the United States have ever been confronted.

Further, this is not a problem which can be dodged or ducked, or otherwise avoided. It is a problem which must be met head on, and met successfully. It is the problem of beating down those aggressor nations that have attacked us; the problem of defending our freedom, our liberties and our chosen ways of life from the greatest threat that has ever been made against them; the problem of winning the war.

War is destruction—destruction of human lives, of homes, of friendships, of hopes, of ideals. War is also destructive of false prides, of special privileges, of unworthy ambitions, and of decadent institutions. It is a fire that consumes rubbish and weeds as well as flowers. When it passes, what is best in human nature often attains ascendancy—even if only for a time—because the pendulum swings from the guillotine to liberty, equality and fraternity.

To win this war—that is our one great problem. And to the satisfactory solution of that problem we must dedicate our hands, our minds, our hearts and our souls. Until we are able to solve this problem, all the others are less disturbing.

It may seem strange to hear that winning the war is the greatest problem of our railroad industry, an industry first created and then devoted for more than a century to the peaceful economic develop-

ment of a continent. But those days of peace now are behind us and will not return until a triumphant America stands over the beaten and prostrate bodies of our foes. This is war, total war, and in total war our essential industries stand shoulder to shoulder with our army and our navy in their spearhead of attack.

For men no longer fight with fist or rock or sword or spear or bow and arrow. They fight today, on the sea, on the land, under the oceans and in the air, with an infinite range of weapons, so varied, so complex, and in such quantity as to strain to the utmost the inventive genius and the productive capacity of the nation. We can rely upon the courage and the strength of our fighting men, but they must be supplied constantly with more weapons and with better weapons than those used against them by our enemies. It is the production line that makes the front line possible today.

Railways Vital

In our great national production line, the railways, as usual, are the main line of transportation—the main line over which must move, in ever-growing volume, the raw materials from mine and forest and field to factory; the main line, too, over which the finished products of tanks and guns and shells must flow unceasingly from our factories to the fighting fronts throughout the world. A ship, or a tank or a gun is just so much raw iron ore, coal and oil until those factors entering into their construction and operation are brought together. And a tank or a gun can wreck no havoc while sitting motionless in a factory.

We are the lines behind the lines—the service of supply of an embattled nation. In our service, a freight car is a weapon, a locomotive is an engine of war. And when the first American tanks roll into the streets of Berlin, Rome and Tokio, we can remember with a thrill of pride that we started them on their journey.

Heavy War Traffic

Today, the War department is by far the largest user in the country of railroad transportation service, both freight and passenger. There is a great movement of supplies of an infinite variety, including both military equipment and materials for the manufacture of the equipment which is being produced for our own army and our allies. Today, it takes more than half again as much materials and supplies of all sorts as were required in the last war to keep a fighting man in the field. This is much more of a mechanized war than the last one. It takes a lot of transportation to provide all those trucks and tanks and jeeps and planes that we didn't have the last time, and to keep them supplied and running and flying. Every change that has been made has increased the transportation load. A division uses more guns now than it did then; each gun in action fires more rounds per minute; and there is more weight in each round. All of this calls for more transportation.

As regards the transportation of our troops, the War department stated recently that movements during the first nine months of the present war were more than three times the number during the comparable period of World War I. In

the nine-month period beginning December 7, 1941, troop movements by rail totaled approximately 6,500,000, as compared with 1,900,000 for the first nine months of the last war.

Then, too, these troops are moving with greater speed and comfort than was the case 25 years ago. In 1917, the average speed of special troop trains was less than 20 m.p.h., compared with an average speed today of 30 m.p.h.

Back in 1917-18, the American soldier was moved an average of three times between his induction into the army and his embarkation for overseas. Today, reflecting both the more intensive training program now being employed and the greater amount of transportation service required, he averages six moves before he leaves the country. The meaning of this to the railroads may be understood more fully when it is realized that the movement of a triangular infantry division of about 15,000 men and their equipment requires 65 trains, with a total of approximately 1,350 cars, while the transportation of the men and the 3,000 vehicles in an armored division requires about 75 trains of from 28 to 45 cars each, depending upon the length of the cars.

Navy Large User of Railroads

Next to the army, the navy is the largest user of rail facilities in time of war. Thousands of freight cars are moving daily in the direct service of our sea forces. The Naval Bureau of Supplies and Accounts alone routes an average of approximately 50,000 freight cars a month, and this does not include shipments under private bills of lading going to plants engaged in

fulfilling navy contracts. To build a battleship or an aircraft carrier or a submarine requires tons upon tons of a large variety of materials. These different materials are scattered all over the country, hundreds, and some times thousands, of miles apart. It takes the railroads to bring these materials to the plants which are manufacturing parts for naval vessels, and it takes the railroads to haul the parts to the ship-building yards.

Not only must our soldiers and sailors be armed and equipped—they must be fed, as well. The American railroads are moving record quantities of food for our army and our navy. It takes about twice as much food to feed a man in uniform as it does a civilian. For instance, a civilian averages 153 lbs. of meat a year, while a man in the service averages 365 lbs., or more than two and one-third times as much. The average civilian eats approximately 500 lbs. of fruits and vegetables a year, while the soldier or sailor gets more than 800 lbs.

To feed our army and our navy requires now about 3,500 carloads of foodstuffs each week. In addition, we are shipping enormous quantities of food to our allies and practically all of this is moved to ports by rail. This export movement amounts to between 700 and 1,000 cars a day. A large number of these cars must travel long distances, often thousands of miles. From the end of April, 1941, to the first of July, 1942, America delivered more than 5,700,000,000 lbs. of farm products to representatives of the United Nations. Nearly all of this traffic was handled by the railroads.

I have discussed the military needs for railroad service at some

length because those military needs are the primary responsibility of the railways today. Meeting them in full is the first problem we have before us. So far, that problem has been met successfully.

Long, Hard Hill Ahead

Gentlemen of the American Railway Bridge and Building Association engaged in the maintenance of our railroads, you, in my judgment, have met and will continue to meet the test. There can be no question from the proof furnished thus far, that you do have a full realization of what we are fighting for in this war, and a full realization of what our railroads must do to bring about complete victory. We still have a long hard hill to climb, and the end is not yet in sight, but you have what it takes, and that is the spirit that insures for us the preservation of our freedom and all that that freedom means in this grand country.

But we have other responsibilities, as well, with their attendant problems. The war has not relieved us of these other responsibilities; it has placed an additional burden on top of them. We still have our normal responsibilities to the people of the United States. They must be fed and clothed and warmed—their essential needs for transportation service must be filled. Meeting that responsibility in full is the second problem we have before us. So far, that problem, too, has been met successfully. We must continue to meet it successfully.

Both of these problems, which, indeed, narrow down to the single problem of furnishing all essential transportation service, have been

complicated and augmented by the fact that the exigencies of war have thrown upon the railroads a substantial part of the traffic load which was carried formerly by other agencies of transportation. Not only has our total volume of national traffic grown; the railroads are being called upon constantly to handle an increasing proportion of an increasing total. The national shortage of rubber; the rationing of gasoline, long since effective in certain areas and soon to become country-wide in scope; the discontinuance of steamship service through the Panama canal; the transfer of many coastwise vessels to other services; the sinking of our ships along our coasts—all of these factors have placed greater burdens upon the steam lines.

Trend of Traffic Upward

Thus, we find ourselves today called upon to furnish the greatest volume of service, both freight and passenger, in the entire history of the railroad industry. Indicative of the magnitude of that service, I call your attention to a statement made public by the Office of Defense Transportation a few weeks ago, before the fall peak demands were reached. In that statement, covering a single day picked at random, it was shown that the 108 railroads which furnish daily reports to the O.D.T., for the 24 hours from midnight to midnight on the particular day covered, had dispatched, over all divisions, a total of 23,578 trains with 1,409,000 cars.

And the trend of traffic is upward. After 1942, there will be still heavier traffic to move. Just

how much heavier, no one can say with certainty, although tentative estimates have been made of a 15 per cent increase in both freight and passenger traffic next year. Civilian production may fall to minimum levels in 1943, but war production is certain to increase. Troop movements will grow as our army and our navy are enlarged. Passenger business will go up as the use of rubber-tired and gasoline-driven vehicles decreases. The railroads will continue to handle such unaccustomed loads as the oil movement to the East and the all-rail movement of coal into New England.

Fewer Locomotives and Cars

The satisfactory handling of the emergency movements following December 7, 1941 was achieved with less rolling stock than was available during the like period in 1917. At the time of the 1917 mobilization, almost 2,600,000 locomotives, coaches, freight, passenger and baggage cars were in the service of the railways, whereas at the start of hostilities in 1941, less than 2,000,000 locomotives and cars were available. Only by surpassing all previous records of operating efficiency in the use of equipment has it been possible for the railroads to meet the unprecedented demands that have been made upon them. But there is a limit to such accomplishments. General Charles P. Gross, Chief of the Transportation Corps of the Army's Services of Supply, has summarized the situation in the following apt words:

"The railroads have used existing equipment more intensively with increasing cooperation between companies. They have re-

duced their unserviceable units and have brought them into use. They have loaded cars more completely. This reserve capacity in heavier loading, in blocking through solid trains, and in unification of effort, is not exhausted, but there is far less fat left. The additional loads that are coming in 1943 must, therefore, be met to a greater degree by new equipment."

In this regard, Director Eastman of the Office of Defense Transportation, has stated: "To avoid any misunderstanding, let me make it plain that I believe new cars and locomotives to be essential. I shall do everything that I can to get them."

This matter of increasing the supply of railway equipment to match, in some degree, the increase in the demand for transportation service, is another of the problems which now confront us — and a problem that must also be met successfully.

Manpower and Material Shortage

Still other major problems confronting us are problems of shortage—in manpower and in materials. Essential though the railroad industry is, we can anticipate, nevertheless, that as the war goes on, more and more railway men, including those in your own department, will be called to active service with our armed forces. We can anticipate, likewise, that the supply of men who normally would be available for railroad employment will be depleted through this same cause and through the demands, as well, of other war industries. This is another of the problems which will confront us with growing intensity. This prob-

lem, too, must be met successfully.

The material shortage is not a matter of mere anticipation in all regards. In some respects it is already an actuality. The unprecedented requirements of the war have created a vast demand for many materials normally used in large quantities by the railroads, both for new construction and for maintenance and repair. So great has been this demand that in many cases it has outstripped available and immediately prospective supply, and a system of apportionment has had to be instituted.

I intend no criticism of the results which thus far have followed; the task of dividing limited supplies among unlimited demands and almost unlimited needs is one which even Solomon might have declined. But the fact remains that the railroads will have to handle their greatest job under severe limitations as to the quantity of various critical materials which they may secure. You may, and probably will, be called upon to do more and more with less and less. You will have to do the best you can with what you have where you are, and, for the sake of America, your best has got to be good enough. This shortage of materials is another of the problems which confront us. This problem, too, must be met successfully, if we are to win the war.

We are convinced that our task in winning the war will be the greatest and the most difficult we have ever known. It will be even greater and more difficult tomorrow than it is today. Your part in the struggle—the safe and adequate maintenance of the railroad track structure, bridges and other essential facilities, is second to

none in its importance. You have had a part in making the American railroads the best in the world. I am certain that you will maintain this record.

Will Meet Acid Test

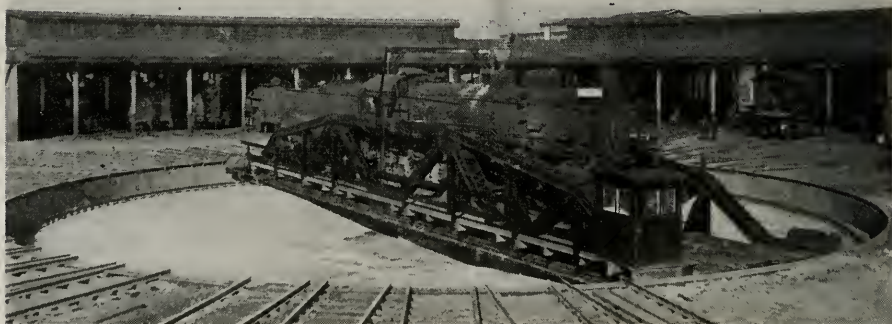
As our normal civilian production becomes more and more curtailed, a higher and still higher proportion of railroad traffic will consist of war materials. In consequence, the peacetime seasonal fluctuations in the volume of rail traffic will be largely wiped out. There will be no slack periods, no breathing spells. On the contrary, it appears that the demands upon the railways will grow almost steadily from month to month. Your task will be made even more difficult by this fact. But, in my judgment, there will be no question as to the ability of our railroad maintenance men to meet this acid test, and I say this advisedly, because I think that I know the "stuff" of which you are made. Personally, I am quite satisfied with the proof to date.

As I have said, our one over-all problem is the problem of winning the war. Stating that problem

somewhat differently, we in the railroad industry face the problem of meeting what may seem to be limitless demands with limited manpower, with limited equipment, and with limited quantities of materials and supplies. But if the demands upon us are limitless, limitless, too, are the ability, the skill, the devotion, the courage and the patriotism of railway men. In those unlimited qualities which have already conquered seemingly unconquerable difficulties, I am certain we will find the successful solution to our problems.

President Dove: Mr. Johnston, we thank you for your thought-provoking address. Beginning our meeting with an address such as you have just delivered has given us the inspiration that will make our meeting a success.

There has always been a bond of respect and understanding between the American Railway Engineering Association and our own. The president of that association, H. R. Clarke, who is also the chief engineer maintenance of way of the Burlington system, is here this morning to bring greetings from that association.



Greetings From The American Railway Engineering Association

By H. R. Clarke, President

The invitation to speak to you was addressed to me as president of the American Railway Engineering Association. It is a privilege to address this association and an honor to do so as president of the association I represent today. However, I wish to speak to you in a dual capacity—as president of a sister association, since it is as such that I am here, and also as a railroad maintenance officer, who is, at least to some extent, aware of the problems that the railroads, and particularly the maintenance of way department, face, and, certainly, as one who is most vitally interested in how successfully we solve the problems.

When you met a year ago, the country was technically at peace. We hoped that war might be avoided, but feared it would not be. Even then we were beginning to feel the impact of war, more perhaps in track and signal work than in the bridge and building department. It was not easy to secure the rail and other metal products we needed for track work; copper and other materials needed in signal work were becoming scarce, but the pinch was not serious in bridge and building work. I think there may have been even a feeling that these activities would not be interfered with seriously. There might be some limitations in structural steel, and possibly electrical fixtures and plumbing supplies might be hard to secure, but otherwise

we could expect to carry on. We know now how false that feeling of security was.

Must Keep Up Maintenance

Today we are at war. We have one task and only one—that is to win as quickly as possible and in the most decisive way. Everything else must give place to this one objective. The railroads have a vital part to play, a tremendous load to carry in the all-out effort, and we who are responsible for maintaining the bridges and structures that carry the war traffic must see to it that we do not fail.

I sometimes sense a feeling on the part of a few that it is unpatriotic to carry on with essential usual activities, to keep up the normal repair and maintenance programs. To me that attitude is weak and absolutely out of order. Fortunately, this applies to very few. The great majority of those in charge of all branches of railroad maintenance well know the importance of adequately maintained tracks, bridges, and signals to the successful operation of the railroads, and what it would mean to the war effort if any of these vital units should fail.

Your officers and directors had both faith and courage when they decided to hold a meeting at this time. The easy way would have been to do as so many others have done—close down for the duration.

In my opinion, that would have been the wrong way. However, one thing, and one thing only, justifies this meeting or our being here. That is, that from it we shall go back to our work and do a better job than we could have done if we had not come. We have that opportunity. It is up to us to take advantage of it.

A month ago, in addressing the Roadmasters' and Maintenance of Way Association, I quoted Joseph B. Eastman and others. The conditions under which the two departments (bridge and building and track) work, and the problems they face are so similar that I hope you will pardon me if I repeat to some extent some of the things I said then. Not long ago Mr. Eastman said, "Maintenance must not be allowed to fall into arrears, and no one has a heavier and graver responsibility than the men who are in charge of this work." Certainly no one is more fully alive to what will happen if maintenance should fall too far in arrears than are the men on the firing line—those who are carrying the responsibility of which Mr. Eastman spoke. No one knows better than they the difficulties that confront them, and no group of men is more grimly determined that they shall not fail.

Must Not Be Caught Napping

Traffic today is heavy, and the wear and tear on the track and structures are at an all-time high. Unimportant lines, on which traffic was light, are now important links in the chain and are carrying a heavier traffic than ever before. That often means larger and heavier engines as well as more and heavier car loads. We must be cer-

tain that our bridges are adequate to carry this increased load and are properly maintained for this heavier and faster traffic. This may call for a radical change in maintenance standards and practices, but we must not be caught napping. Fueling stations and water supplies that were used only infrequently and to a very limited extent are suddenly called upon to furnish service far beyond that for which they may have been designed. Initiative, resourcefulness, and ingenuity on our part are needed to do the things that must be done, but the job is ours and we know how to do it. No where are the qualifications I have just mentioned more needed, and no where are they found more frequently than in the bridge and building forces. When called upon to tackle an emergency, I have experienced that feeling of inward confidence that I suspect has come to most of you when you knew that you had a well-organized, fully-equipped bridge gang ready to wade in with you.

Must Have Needed Materials

So far the railroads have done a splendid job. That is generally recognized and the roads have been complimented by many in the best positions to know just what has been done. The fear has been expressed by some that we might become self-satisfied and complacent, and feel that our part was done, our battle won. I have no fear such an attitude will develop. That has not been our training. We believe that no matter how well a job has been done, it can be done better. If failure should come, it will not be due to lack of determination and effort on our part. There

is one thing which does give us all deep concern. Some in authority know that for the railroads to continue their outstanding record of service, they must have a reasonable amount of vitally-needed materials and be protected in their labor supply to the same extent as other essential war industries. Mr. Eastman and some of his staff know this, and in them we have influential friends at court, but is that enough? A member of the War Production Board said recently, "But the railroads have met successfully all demands imposed on them up to now, as a result of the war program, and I am supremely confident that the job will continue to be done no matter what further restrictions are necessary." Every railroad employee will do his utmost to deserve and justify that confidence, but I hope and believe that the fallacy of this reasoning, "No matter what further restrictions are necessary," can and will be presented in such a way by those who do understand the situation correctly, that the tragic phrase, "Too little, too late," will not apply to the railroads.

Labor a Problem

We have already found the going hard and know that it will become even more difficult. There has been a surplus of labor for the last 12 years. Today there is a shortage. Many men in supervisory capacities today have had no previous experience handling men under conditions as they are at present. New methods must be tried for recruiting labor and an intensive training program must be developed and carried out. The foreman and supervisor must be alert as never before to find men

with the necessary latent ability and to train them for the work they must do. I do not mean to say that our forces should be coddled—emphatically, they should not be, but everything within reason should be done to make the employment offered attractive.

The material situation is fully as critical as that of labor, and it is our responsibility to determine most accurately just what is needed and when, and then to see that advice is given through the proper channels. When it can be done, less critical materials must be substituted for those which are more in demand. Here again, ingenuity and resourcefulness are needed. The phrase, "Too little, too late," has been heard all too often, and it has come to have an almost sinister meaning. Let us do all we can to see that it does not apply to our work; and equally as important, we must be certain that no surplus or unneeded stocks are allowed to accumulate. Material or equipment unused in one place may be needed most desperately somewhere else to prevent a crippling breakdown.

The human equation must be considered at all times. All men do not have equal ability to see and to do the things that should be done. We can all profit by the advice and experience of others, and it is in meetings such as this, if we take advantage of the opportunity presented that this information can be most readily acquired.

We have been at war a little more than ten months with the most ruthless nations of modern times. Since December 7, 1941, there have been few days, either in our private affairs or in our

service to the railroads, that we could forget that fact; that the pace is becoming faster; the demands greater. We are familiar with the job the railroads are being called upon to do, how vital it is, and how well it is being done. We know how difficult it has been, but we also know that failure would be tragic, almost fatal. Therefore, we are determined to do our part, that we shall not fail, and this meeting can, and I am certain will, help in that endeavor.

As president of the American Railway Engineering Association, I bring to you the good wishes of each and every member of that association, and express the confident conviction that, in this time of need, this meeting will surpass in effectiveness and in value to you and the railroad industry any which the Bridge and Building Association has ever held.

President Dove: Mr. Clarke, we thank you for conveying the greetings from your association and for the timely remarks you have made. We also appreciate the rearranging of your railroad trip so you could be present with us at our opening session.

One month ago another railroad association met in this room and had one of the most successful meetings of its career. I refer to the Roadmasters' and Maintenance of Way Association. There has always existed a warm feeling of cooperation between our organizations and in the furtherance of that feeling, the newly elected president of the Roadmasters' Association, E. L. Banion, roadmaster on the Santa Fe at Topeka, Kan., has come to us today with greetings from that association. Mr. Banion.

Greetings from the Roadmasters' and Maintenance of Way Association

By E. L. Banion, President

It is a pleasure and an honor to bring to you the greetings of the Roadmasters' and Maintenance of Way Association at this, your Forty-Ninth Annual Meeting.

Your association has a long and enviable record of accomplishments, and we of the Roadmasters' Association have enjoyed the close contact which has existed from the beginning between our two organizations. Our problems are related closely in many respects, and these have multiplied many fold in recent months. You men of the bridge, building and water service

field are being called upon to shoulder a greater load than most of those in the other departments of our railroads.

A hasty review of your program convinces me that you have taken the courageous stand in going ahead with your annual meeting, even though you knew the task would not be an easy one. The program of your meeting is keyed so closely to the war effort that there can be no misunderstanding as to your purpose. While you, in common with other maintenance men, have seen difficult days in the

past, there may yet be even more difficult days ahead. Much depends upon the transportation forces fighting a good battle on the home front, and I am confident that you men will not let our fighting men down. You must go on, and by your efforts help keep the railroads in a condition adequate to transport the requirements of our war effort.

I know that each of you feels very deeply the added responsibilities which have been placed upon you by these war-time conditions, and that you assume this responsibility with confidence, knowing that your effort, and the efforts of your associates, will be adequate to meet the new demands, whatever they may be.

Must Overcome Labor Shortage

The building forces of the railroads were the first to feel the pinch of the hard times when so much of the traffic ordinarily handled by the railroads took to the highways. There was also a further falling off in the earnings of the railways during the difficult Thirties, that made funds unavailable for a much-needed building program. During the two years prior to Pearl Harbor, there was a convalescent period, but the patient was far from recovered when the attack in the Pacific started what have now become the most urgent transportation demands ever made on the American railroads. We are convinced that with an additional two years of this recovery, much would have been accomplished in overcoming the enforced deferred maintenance of the last decade.

Today, we face a serious shortage in railway labor. In some sec-

tions of the country the supply has been exhausted for many months. While I have no simple solution for this problem, we can do much to help ourselves by adopting into our ranks men who were considered unsuited formerly for such work. We must, whenever possible, adapt machines to take over the tasks of skilled workmen, to meet the falling-off in manpower. We must work our machines longer hours; two or more shifts each day, if necessary, to secure their maximum output. We must secure machines with the widest range of usefulness possible to insure their continuous operation throughout the year, not alone by our own departments, but also by the various other departments requiring such machines. We must secure full co-operation between the several maintenance crafts to avoid lost time in moving machines from one job to the other, or in waiting for machines to be released. The programming of work to provide a uniform force throughout the year will do much to prevent the loss of our present force to other industries.

Avoid Hoarding

It has been said that there must not be "too little, too late." On the other hand, there must not be "too much, too soon." There must be no hoarding of repair parts, emergency or working stocks in excess of immediate needs. Excess repair parts or surplus stocks should be turned into the central supply section, rather than hoarded by any individual or gang. Working stocks should be held to a minimum. Tool and material cars should be inspected frequently to avoid overstocking. Material that cannot be

repaired and returned to use should be scrapped and disposed of promptly.

In view of the serious shortage of railroad equipment of all kinds, particularly of rolling-stock, we must release company loads promptly. Self-propelled locomotive cranes, shovels, pile-drivers, derricks and similar equipment should be used whenever possible to preclude the use of locomotives. The present scarcity of critical materials will force the use of substitutes for many of our most commonplace materials of the past, including brass, copper, rubber, tin, alloys, and metals of many kinds. I am certain that you men will find ways and means of providing these substitutes as the occasion demands. Many of these substitutes will emerge from this crisis as standard materials; may even be found to be superior to those used previously.

Again, I take the privilege of extending to you greetings and best wishes from the Roadmasters' and Maintenance of Way Association, knowing that you will have a most instructive and successful meeting. It has been a pleasure for me to be with you today.

President Dove: Mr. Banion, I thank you on behalf of our association for the greetings from your association, and for your stimulating address.

Past-Presidents Introduced

At this time, I should like to introduce to you the men at the speakers' table. At my far right is A. E. Bechtelheimer, engineer of bridges, Chicago and North Western and president of this association in 1940. At his left is

Armstrong Chinn, chief engineer of the Alton, and president of this association in 1939. Next is T. H. Strate, division engineer of the Milwaukee, who was president of this association in 1936. Next is F. E. Weise, member of my road, the Milwaukee, who was president of this association in 1920.

On my left is A. Montzheimer, retired chief engineer of the Elgin, Joliet & Eastern, who is the oldest past-president present here this morning, having been president in 1904. On his left is L. D. Hadwen, a former employee of the Milwaukee, who was president of this association in 1915. On his left is John S. Huntoon, with the Michigan Central at Detroit, who was president of this association in 1930. On his left is A. G. Shaver, a consulting engineer, who is secretary of your association.

Letters Received

We have received a number of letters and greetings from past-presidents and friends of the association, a few of which you might like to hear. Mr. Hofacker has written that he is now 79 years old and has been a member of this association for 35 years; is in fine health and would be here except for the war conditions now prevailing.

Mr. and Mrs. Joseph Spencer have written that they had hoped to be able to come to this convention.

Mr. and Mrs. Ailes wrote and asked to be remembered, and mentioned that they celebrated their 59th wedding anniversary on August 23 of this year. Mr. Ailes is 81 years old.

Past-president E. C. Neville

wrote that he would be unable to attend and expressed his regrets as he felt that the program would be worthwhile. He wishes us all the best for a successful meeting.

H. I. Benjamin, president in 1935, states that he is making a strong effort to be here to renew old friendships. He also suggests as a new subject for next year's study, the fire-protection of railroad properties. He mentioned that if he was not able to be here today, he wanted to be remembered to you all.

I also have a letter from J. P. Woods. He is a "characteristic" member of this association, you might say, in that he has always been a live wire and very friendly. I shall read his letter. It is from Lakeland, Fla., "To all Concerned—Greetings: While you are already doing your best to serve the railroads, just take three or four more notches in your belts and go to it with every ounce of energy you possess for your Uncle Sam. Whatever you do will not be enough.

"You all know that when we had to get out on the line in case of a fire, wash-out or wreck, hours meant nothing. If we got a snack to eat we were happy; if not, we jumped in a little harder to get the job done. We have a job to do now to lick the "daylights" out of the **dirtiest wretches** the world has ever known, and we **will** do it, never fear.

"Yes, we like it here; have good times; good health; good food and are happy. We both belong to the Retired Railway Men's organiza-

tion and enjoy meeting with other old railroaders. And do we railroad?

"We have a comfortable home; plenty of citrus fruits of various kinds; and have room for plenty of flowers and vegetables. Also lots of friends. Go to church—all the pot-luck luncheons and suppers; play some golf; and do we enjoy it!

"If any of you want to have an argument with me, come down and I will try to accommodate you.

"Hope you have a whopper of a convention. Kindly remember Mrs. Wood and me to all of our friends."

President Dove: I have a letter from W. A. Rogers, past-president in 1901, which I shall read in part:

"I have your nice letter of October 8, asking me to be present at the coming annual meeting of the American Railway Bridge and Building Association.

"I have been confined to my home with a heart ailment for the last three months and, while I am out doors once more, I am sorry that I will be unable to be present.

"I feel proud to have been actively associated with the Bridge and Building Association while I was with the Milwaukee. It is a great organization of men who are endeavoring to further the interests of their railroads and who are loyally helping their country. Please present my best wishes for the continued success of the American Railway Bridge and Building Association.

Next on the program is the President's address.

President Dove's Address

This annual meeting of our association is unusually significant. We are meeting at a time when our nation is at war, and all of our efforts are, or should be, directed toward the sole objective of winning the conflict. This is not the first time, however, that we have met during critical days, because, as an association, we passed through the Spanish-American War and World War I. Notwithstanding the disturbing and tense days of this last year, your officers and committees have gone on with the work of the association, resulting in the preparation of reports which are as fine as any presented heretofore.

Your Executive committee had four official meetings during the year, supplemented by luncheon meetings of local past-presidents and members of the Executive committee, to further the interests of the association. While making reference to these meetings, I wish to acknowledge the help given to me by these loyal men, and I thank them again for it. In addition to the forementioned meetings, we had an informal Get-Together luncheon during the meeting of the American Railway Engineering Association in March, at which 42 of our members assembled.

Membership Campaign

A membership campaign was inaugurated, having as its slogan, "Every Member Get a Member," but I regret to report that this met with indifferent success as only a

slight increase in the usual number of applications resulted. I feel that the main reason our campaign was not more successful was that many of us are too timid to ask a fellow worker to join. I wonder why. You are not asking him to join a "fair weather" organization and to spend his money foolishly. You are really being of service to him.

In connection with this annual meeting, I wrote to a large number of the chief operating officers, chief engineers and bridge engineers of the various Class I railroads, calling their attention to it. Among the many favorable replies received, was one from the chief engineer of a large Eastern road, which read as follows: "This will acknowledge receipt of your letter of October 10 relative to the 1942 meeting of the American Railway Bridge and Building Association at Chicago. I am calling the attention of some of my staff to this meeting and hope that our road will be well represented. I consider the Bridge and Building Association one of the best conducted associations in the railway field, and anyone who can spare the time to attend will, no doubt, be well repaid."

Now, when a chief engineer has such a high regard for our association, you may rest assured that he, and others in similar positions, will have a high regard for its members.

With respect to membership, I must mention also that no serious effort has been made to secure junior members as now permitted by

the Constitution, as amended last year. I urge you to keep before you the idea of securing new members. In securing new members, the association benefits, the new member benefits, and you gain by what the new member brings to us in ideas.

We had three issues of the B. & B. News during the year to acquaint you with the work of the association, and also to maintain that friendly feeling that is characteristic of its members. An index was added to this year's volume of the Proceedings to make our library more serviceable as a reference. We get many requests for copies of our Proceedings from railroads, universities and libraries—one railroad request coming from as far away as Brazil. This indicates, in part, the high regard in which our studies, committee reports and discussions are held.

Our expenses this year were heavier than heretofore, as the treasurer's report will reveal, due largely to the increased cost of printing our Proceedings and the fact that we are now paying for office rental for our secretary and our records. Yet, I do not feel that our finances are in serious jeopardy because we were late in getting out our 1943 dues notices and the payments had not yet been received at the time the treasurer's report was made up.

This brings up the matter of dues. If you will take the time to browse through your library of the Proceedings of past years, you will note that almost without exception, the president reminds the members of the importance of paying their dues. I might also mention here that the By-Laws of this association stipulate that dues

are payable in advance, and the business affairs of the association are conducted on that basis. It handicaps your officers seriously when dues payments lag, and much postage, stationery and time of the officers are spent in reminding members of their neglect. Some members are never behind in their dues, and these men, one finds, are generally the most active. They are not only putting something into the association, but are getting the most out of it.

Big Task Ahead

Our meeting here today can be attributed to the fact that your officers felt that such a meeting would be of help to our national war effort. Transportation, from the beginning, has been connected with carrying on warfare successfully, be it offensive or defensive.

In modern warfare, the amount of munition expended each day is enormous. Our weapons have been devised to the end that our soldiers will have the greatest firepower possible. It used to be said, "To get there fastest with the mostest men." Now it is "Get there fastest with the mostest men and **materials.**" One, without the other, is not enough. We all know well the expressions, "Too little and too late."

The railroads are by far the most dependable and satisfactory of all means of transportation. On Germany's Western front, where there are no large systems of highways to convey her troops, supplies and equipment, she has had to rely heavily upon the railroads. Each contestant is busily engaged with bombing missions upon the other's railroads to destroy that means of supply as quickly as possible. It is

needless to enlarge on the importance of the railways during war periods, because it is only too clear that we must keep our railroads functioning properly in order to achieve our objective of winning the war.

Today, our railroads are faced with the task of handling the largest amount of tonnage they have ever carried, and it must be done with less manpower, equipment and materials. The nation is producing great quantities of heavy war materials that must be moved quickly to the points of use. It is what we do today that counts. The year 1942 will witness a peak in the production of heavy supplies of war, and we have been told that the goal of production in 1943 will be revised upward. On top of all this, our competitors in the transportation field will be handling less than before, as trucks are rationed and our coastal shipping is being transferred to overseas duty. We have been disinclined to complain in the past about not getting that business best suited to rail transportation, because of unfair subsidies to our competitors and the restrictions and regulations placed upon us. The Association of American Railroads has done much to present our viewpoint to the public and to advertise the railroads. The best form of advertising, though, is a job well done. Now our competitors have been removed temporarily and the business is practically all ours. Therefore, it is up to us to show what we can do. If we are to be the efficient arsenal for the United Nations and provide our fighting men with what they must have, the job **must** be done and done **now**.

A recent public opinion survey

of the Association of American Railroads developed that the public fully expects the railroads to handle the transportation load, even though peak is piled upon peak. It will be a sorry day for us if we do not measure up to this confidence. The public will not be sympathetic to any alibis when it is faced with adjusting its own habits to the rationing of clothing, food, car use, and even transportation. What can we do about it?

Obviously, it is not a one-man job, nor one for management or for employees alone, but it is one that can be done through the co-operation of both, plus a little understanding help from the shippers and from the powers in Washington. We here are all officers on our railroads, and, as such, we are in the paradoxical position of both establishing and carrying out certain policies. We can do more to help our roads than many employees during this critical war period.

As railway officers, we are entering a period of unusual opportunity to exercise our ingenuity for maintaining our facilities in the face of a limited supply of labor and materials, a supply which will probably decrease before it increases. We will not have all of the materials that we think we need. The man with the practical, inventive ability will come into his own as many occasions will arise when this quality will be demanded. The railway officer who is alert to any situation that springs up, who is self-reliant, and who will employ his creative faculties in useful practices, will be the one whose facilities are the least impaired after our battle is won.

We cannot look far into the fu-

ture and do not know how long hostilities will last, but for us to exert ourselves to the utmost in this all-out war effort, we must concentrate upon the immediate problems at hand, and not adopt a long range maintenance policy. By this I do not mean that we should deliberately neglect our facilities and attend only to work that, if not done, will soon require entire renewals, or court disaster, for we all well know that a minor repair in time will prevent a major one later. Yet, I do say that the sooner we forget the work that can just as well be done two years from now, without seriously impairing the strength of our facilities, the greater will be the contribution to our national power.

Wise Use of Labor

Also, as railway officers, you have already felt the loss of some of your valuable foremen and workers to the military services and to other more lucrative occupations. What about the loyal men who have remained with you? You cannot stay the arm of the military when it selects your men, but you can conserve for the railroads those men with sufficient initiative and ability who will be leaving for work elsewhere if they are not given greater reward and responsibility. Some officers have built up small organizations that practically run themselves, and they hesitate disturbing them. While I can understand this attitude, for it represents an achievement and hard work on their part, it has no place at present. It must give way to the exigencies of the times, realizing that the knowledge and experience of these loyal men can be used better in spread-

ing these qualities over the entire organization of workers.

Already the military is looking at our younger men, those 18 and 19 years old, who we thought we could safely employ and train. This means that we will be increasing the average age of our employees, which, in turn, will call for closer supervision than in the past to safeguard these men, many of whom will be called upon to work, who will, of necessity, be working longer hours, with greater fatigue. That is why I say we should husband those men who can be made into foremen, and thus prevent them from turning to the alluring profits of other employment. We should take the hint from the signs going up in mining, lumber and railroad camps—"Be Kind To Your Cook."

Have Confidence

As employees, we should have faith and confidence in our superior officers and those in other departments. When things are provoking and distressing, we should not condemn these men as bunglers. How often we have heard people blaming the heads of agencies in Washington for this and that, and for being inefficient. For one, I believe that most of those men are doing the best they can. I know a few contractors who have been called to Washington to confer on large contracts, and they tell me that they were impressed by the knowledge and efficiency displayed by their conferees. We should believe, for example, that our purchasing and stores departments and our superior officers are doing their best to secure the necessary materials for us, and that they, too, are limited as to what they can do.

Also, as employees, we can help considerably in the national scrap campaign. The railroads are still the chief source of supply for scrap. The amount they turn in, when mixed with other materials, produces three times the amount of new steel which they request. Yet, in our enthusiasm to scrap materials, we should not overlook those materials that can be rehabilitated, and cast them into the scrap heap. To do this, we might create a situation calling for the use of new materials.

In first aid, we learn that the chances for recovery of the victim are greater if treatment is given in the first precious minutes after injury. This is likewise true in the care of our work equipment—equipment that will become more essential to us as our labor problem becomes more acute. It would be well for us to bear this in mind, at least until this condition is relieved.

Railroad men have always been patriotic and quick to rise up in support of their country in times of stress. I have the utmost confidence that they will meet again the many problems of the present emergency, and that they will do it **now**.

I would like to close my remarks with a saying from one of Carlyle's essays called "Signs of the Times": "Our grand business undoubtedly is, not to see what lies dimly in the

distance, but to do what lies clearly at hand."

Committees Appointed

President Dove: The next order of business is the appointment of Special committees.

Nominations: A. E. Bechtelheimer, chairman; C. M. Burpee, H. M. Church, Armstrong Chinn and Elmer T. Howson.

Subjects: F. H. Soothill, chairman; G. S. Crites, A. M. Knowles, J. L. Varker, N. D. Howard, R. E. Caudle and I. A. Moore.

Auditing: T. H. Strate, chairman; R. P. Luck, George E. Boyd and Martin Meyer.

Resolutions: N. D. Howard, chairman; R. E. Caudle, W. A. Batey and W. A. Huckstep.

Convention City: G. S. Crites, chairman; R. E. Caudle, J. S. Hutton and L. G. Byrd.

Obituary: C. R. Knowles, chairman; F. E. Weise, G. S. Crites and J. L. Varker.

President Dove: We are now ready to take up our committee work, and I will ask E. H. Barnhart, chairman of the committee on Preventing Accidents Among Bridge and Building Employees, to come to the platform.

. . . Mr. Barnhart presented the report. (See page 46.)

. . . Recessed at 12:30 p.m.

Afternoon Session

Tuesday, October 20, 1942

The meeting was called to order at 2:10 p.m., President Dove presiding. The first part of the meeting was taken up by the continuation of the discussion of the report on Preventing Accidents Among Bridge and Building Employees, (See page 46) following which President Dove introduced B. R. Kulp, chief engineer of the Chicago & North Western, who spoke on The Protection of Railway Structures in Time of War. (For Mr. Dove's introduction, Mr. Kulp's address, and the discussion which followed, see page 99.)

President Dove: Our next committee report will be on the Cleaning of Masonry Buildings by a committee of which W. A. Huckstep, general supervisor of buildings, Missouri Pacific, is chairman. Will Mr. Huckstep and his committee please come to the platform to present their report.

... Mr. Huckstep presented the report. (See page 176.)

President Dove: The next matter of business on our program is the

report of the Committee on Meeting the Demands for Increased Water Supplies in Fast Freight Service, of which J. P. Hanley, water service inspector, Illinois Central, is chairman. Will Mr. Hanley and his committee please come to the platform.

... Mr. Hanley then presented the report. (See page 76.)

Elmer T. Howson: You may be interested in knowing that somewhat more than 95 railway men have already registered at this meeting, and that this compares with the 117 a year ago. This is somewhat better than 80 per cent. If some of the men who have not registered will do so before they leave the floor, our attendance this year will approach that of a year ago, which I think is quite pleasing in view of the marked change in conditions that has developed during this last year.

President Dove: Thank you, Mr. Howson. We will now stand adjourned until this evening.

Recessed at 5:00 p.m.

Evening Session

Tuesday, October 20, 1942

The meeting was called to order at 8:15 p.m., President Dove presiding.

President Dove: One of the problems confronting railway bridge and building officers for the first time is proper means for blacking

out our railroad structures as a precaution against air raids. Added to this is the problem of illuminating these structures, where necessary, as a means to prevent destruction through sabotage. This is calling for a new technique.

To discuss this subject, we are fortunate in having with us this evening a man who is a recognized authority in this field, having been selected by his company to conduct exhaustive research and development work of this character. This man is W. G. Darley, illuminating engineer of the Lamp department

of General Electric Company, who comes to us from the headquarters of his company's illuminating department at Nela Park, Cleveland, Ohio. It is a pleasure to present Mr. Darley.

. . . Mr. Darley then presented his address, which he illustrated with lantern slides. (See page 86.)

Morning Session

Wednesday, October 21, 1942

The meeting was called to order at 9:15 a.m., President Dove presiding.

President Dove: The first business to engage our attention this morning will be consideration of the report of the Committee on Wearing Surfaces for Building Floors, Platforms and Roadways. This committee is headed by T. H. Strate, division engineer, Chicago, Milwaukee, St. Paul & Pacific. Will Mr. Strate and his committee please come to the platform to present their report.

. . . Mr. Strate read the report. (See page 204.)

President Dove: The next business of the association to engage our attention is an address on labor. The labor situation is a matter of great interest to us these days. Already, we have seen many of our employees leave for military service and for other occupations. This problem is becoming so acute, and our need for skilled men so serious, that we have sought authoritative information regarding it from the Division of Transport Personnel of the Office of Defense Transportation. Edwin M. Fitch, assistant director of the Division

of Transport Personnel, at our invitation, has come to us from Washington to tell us, from a nationwide point of view the outlook for labor in bridge, building and water service. It is with great pleasure that I present Mr. Fitch.

. . . Mr. Fitch then addressed the meeting. (See page 61.)

President Dove: Next to occupy the attention of our association is the report of the Committee on the Conservation of Bridge, Building and Water Service Materials. F. G. Campbell, assistant chief engineer, Elgin, Joliet & Eastern, is chairman of this committee. Will Mr. Campbell and his committee please come to the platform.

. . . Mr. Campbell then read the committee report. (See page 69.)

President Dove: This completes our program for this morning, which will be followed by one of the highlights of our meeting—our annual luncheon at 12:15, which is to be addressed by Ralph Budd, president of the Burlington System. We will, therefore, recess for that luncheon, to reassemble in this room at 2:00 p.m. to continue our program.

. . . Recessed at 12:05 p.m.

Annual Luncheon

Wednesday, October 21, 1942

President Dove: Members of the American Railway Bridge and Building Association, distinguished guests and friends:

I am happy to welcome you today. This luncheon is one of the highlights of our convention. Yesterday, we had the pleasure of listening to C. E. Johnston, chairman of the Western Association of Railway Executives, and a member of our association for 31 years, who made the opening address at our meeting.

Since then we have heard from H. R. Clarke, chief engineer maintenance of way of the Burlington system; B. R. Kulp, chief engineer of the Chicago & North Western; and Edwin M. Fitch, assistant director of the Division of Transport Personnel of the Office of Defense Transportation. Interspersed with these addresses have been the reading and discussion of our own committee reports.

Today it is our privilege to hear another eminent speaker, but before he is presented, I am going to call upon Elmer T. Howson, past-president of this association, to introduce the distinguished guests at our speaker's table. Mr. Howson.

Elmer T. Howson: Mr. President, members and guests:

We are proud of the executives of the railways who have joined with us in this feature of our Annual meeting. It is my privilege to present them to you, together with the officers of the Bridge and Building Association who are gathered at this table.

Starting at my right, Neal D. Howard, engineering editor of the Railway Age, managing editor of Railway Engineering and Maintenance, and vice-president of the Bridge and Building Association.

E. A. Dougherty, assistant to the vice-president of the New York Central Lines, Chicago.

D. P. Beach, assistant chief of the Maintenance Equipment Section of the War Production Board, Washington.

Clarence R. Knowles, former superintendent of water service, Illinois Central, and a past-president of this association.

Carl Howe, vice-president of the Erie, Chicago.

A. E. Bechtelheimer, bridge engineer, Chicago & North Western, and past-president of this association.

T. E. Bond, president of the Elgin, Joliet and Eastern.

E. Flynn, executive vice-president, Burlington system.

F. H. Soothill, first vice-president of the American Railway Bridge and Building Association and chief estimator of the Illinois Central.

Starting at my left, A. G. Shaver, secretary of the American Railway Bridge and Building Association.

E. M. Fitch, assistant director, Division of Transport Personnel, Office of Defense Transportation.

M. F. Stokes, president of the Chicago and Western Indiana and the Belt Railway of Chicago.

Samuel O. Dunn, chairman of the board of the Simmons-Boardman Publishing Corporation and

editor of the Railway Age,

A. M. Knowles, engineer of structures of the Erie and vice-president of the Bridge and Building Association.

C. E. Johnston, chairman of the Western Association of Railway Executives and associate director, Office of Defense Transportation.

G. S. Crites, division engineer of the Baltimore & Ohio and second vice-president of the Bridge and Building Association.

H. A. Scandrett, trustee of the Milwaukee system.

President Dove: Thank you, Mr. Howson.

I feel I should thank these distinguished guests for meeting with us today.

We always feel that our association is worthwhile; that the things we take back to our railroads are helping them and consequently helping the nation in its military effort. It is encouraging to have these gentlemen with us as it strengthens this belief.

... President Dove then introduced the speaker at the luncheon—Ralph Budd, president of the Burlington System (for his introduction and Mr. Budd's address, see page 198).

Afternoon Session

Wednesday, October 21, 1942

The meeting was called to order at 2:27 p.m., President R. E. Dove presiding.

President Dove: Along with the labor problem, the acute need of critical materials presents another vital problem for the railroad man. It is an issue which we cannot evade and we must face it to decide how best to meet it.

Our program this afternoon is devoted wholly to the subject of materials, and from the attendance here, it is evident that the Arrangements committee was justified in the selection of this subject. The lineup for this afternoon is first to have us informed about the critical materials from an authoritative source, and then later to have addresses as to what we can do about making the best of the situation.

We are very fortunate in having with us a man who is an authority

on the subject. Mr. Beach is a railroad man of many years' experience, having come up in the engineering department of the Pennsylvania to division engineer and engineer maintenance of way of a Grand division. It is fortunate for the railways that the War Production Board has enlisted a man of his background to pass upon the questions that are of such great importance to our members.

It is with pleasure that I present to you David P. Beach, assistant chief of the Maintenance Equipment Section of the War Production Board, Washington, D. C. Mr. Beach. (For the address of Mr. Beach, see page 127.)

President Dove: Gentlemen, our program has been arranged this afternoon so that Mr. Beach could make the opening remarks in

regard to our critical material situation and outline what we are facing so far as Washington is concerned. For the further development of this material program, we have invited several prominent men to speak to you from the viewpoint of a bridge man, the viewpoint of a building man, and the viewpoint of a water service man.

First, we will get the viewpoint of an experienced bridge man. No one is better qualified to discuss the problem of material supply from the standpoint of the bridge engineer than our next speaker. As bridge engineer of all New York Central Lines, west of Buffalo, he has large responsibilities. His standing in this field is evidenced also by the recognition that has been accorded him in the American Railway Engineering Association, in which organization he has been honored by election to the Board of Direction and selection as Chairman of important committees. Mr. J. B. Hunley.

(For Mr. Hunley's address, see page 130.)

President Dove: You will notice that our program shows that A. L. Sparks, architect of the Missouri-Kansas-Texas Lines, will speak on the Problems of Material Supply from the standpoint of the building men. We received a telegram this morning, however, that conditions had arisen which prevented Mr. Sparks from being with us today. O. G. Wilbur, appraisal engineer, and until recently, field engineer, building department, of the Baltimore & Ohio, has consented to take Mr. Sparks' place. Mr. Wilbur is a former chairman of the Committee on Buildings of the American Railway Engineering

Association. His service in that capacity and his years of service with the Baltimore & Ohio qualify him to speak on the Problems of Building Materials. We are especially obligated to Mr. Wilbur because of his willingness to pinch-hit on this short notice. Mr. Wilbur.

(For Mr. Wilbur's address, see page 135.)

President Dove: You will notice that these men are still at the speakers' table, and I am asking them if they will stay so that after the presentation of the remarks of the next speaker, you will have the opportunity to ask questions in regard to materials that might be bothering you.

Although himself a newcomer in our association, our next speaker follows an illustrious line of predecessors in the Water Service department of the Illinois Central. He took over the responsibilities of superintendent of water service of the Illinois Central relinquished by our past-president and longtime active worker, C. R. Knowles, on May 1.

Mr. Martin is no newcomer in water service work, however, having been engaged in this branch of railway service for many years on the railway which has recently called him to head this department. Mr. G. E. Martin.

(For Mr. Martin's address, see page 139.)

... The next item on the program was an address by R. P. Hart, bridge engineer, Missouri Pacific, who spoke on Possibilities for Reclamation and Salvage. (For President Dove's introduction of Mr. Hart, Mr. Hart's address, and the discussion which followed, see page 189.)

President Dove: Gentlemen, we will stand adjourned, until this evening, when we will have an informal dinner together. It will be a family party, which is characteristic of the functions of this asso-

ciation. At 8 p.m., we will return to this room for some group singing, and to hear an address by Sam Campbell, Naturalist, on Wild Life in the North Woods.

... Recessed at 4:37 p.m.

Morning Session

Thursday, October 22, 1942

The session was called to order at 9:30 a.m., President Dove presiding.

President Dove: Gentlemen, the meeting will please come to order. The first business to engage our attention this morning is the report of the Committee on Rail Fastenings on Bridges, Pits and Turntables. J. S. Hancock, bridge engineer of the D. T. & I. is chairman of this committee. Will Mr. Hancock and the members of his committee please come to the platform?

... Since Mr. Hancock had a bad throat, the report was read by G. S. Crites, vice-chairman of the committee. (See page 105.)

The next item on the program was an address by W. D. Beck, district manager of the Car Service division of the Association of

American Railroads, who spoke on Reducing Demands for Cars and Locomotives for Handling Bridge, Building and Water Service Materials in a Period of Maximum Traffic.

(For President Dove's introduction of Mr. Beck, Mr. Beck's address, and the discussion which followed, see page 212.)

President Dove: It is becoming rather late in the morning, but I think we still have time for the presentation of the next report on The Repair of Steel Bridges. A. R. Harris, assistant bridge engineer of the Chicago and North Western, is chairman of the committee which has prepared this report. Will Mr. Harris and his committee please come to the platform?

... Mr. Harris then read the report. (See page 147.)

Afternoon Session

Thursday, October 22, 1942

The final session of the convention was called to order at 2 p.m., President Dove presiding.

President Dove: The last thing this morning we heard the presentation of the report on the Repair of Steel Bridges, by a committee of which A. R. Harris, is chairman.

If Mr. Harris and his committee will please come to the platform, we will proceed with the discussion of that report.

For the discussion, see page 147.

President Dove: The next report for consideration by this Annual meeting is on Piles and Pile Driv-

ing. W. F. Martens, general foreman, bridge, building and water service, Atchison, Topeka and Santa Fe, is chairman of the committee which has prepared this report. Will Mr. Martens and his committee please come to the platform?

... Mr. Martens then read the report. (See page 158.)

Convention Reviewed

President Dove: About two years ago, a practice of summing up the activities at our Annual convention was instigated, and it proved so informative that we are continuing it this year. I have asked my good friend and our past-president, A. E. Bechtelheimer, bridge engineer of the Chicago & North Western, to sit in on all of our sessions, sum up the meeting, and tell us what we have gotten out of it and what we can take home to our railroads. Mr. Bechtelheimer will review the highlights of our meeting as he sees them.

... (For Mr. Bechtelheimer's review, see page 222.)

Elmer T. Howson: (Ry. Eng. & Mtce.): Mr. President, you may be interested in the fact that the registration at this meeting has totaled 322, of which 190 were railroad men—or only 5 less members than registered at the convention a year ago. As Mr. Bechtelheimer said, the attendance has been 86 per cent as large as last year, which exceeds the expectations of everyone. The manner in which the men have remained in the meeting has demonstrated their intense interest in the program.

President Dove: That record proves, without doubt, that any hesitancy that you officers may have had about holding this Annual meeting was unwarranted, and justifies their decision that it be held. This meeting has been very much worthwhile and of real benefit.



Business Session

President Dove: The next order of business will be our business session. The first item of business will be the reading of the secre-

tary's report. A. G. Shaver, our secretary, will please submit this report.

Secretary's Report

Active membership, October 7, 1941.....	505	
New members added during year.....	46	
		551
Died	8	
Resigned	9	
Dropped	32	49
Total.....	502	
Associate members, October 1, 1941.....	18	
New members added.....	1	
Total.....	19	
Died	1	
Dropped	2	3
Total.....	16	16
Total active and associate members.....	518	
Life and retired members.....	99	
Total active, associate, retired and life members.....	617	
Honorary member.....	1	
Total membership, September 30, 1942.....	618	
Total membership, October 1, 1941.....	594	
Gain during year.....		24

President Dove: You have heard the reading of the secretary's report. If there are no omissions or corrections, it will stand approved as read.

Secretary Shaver: Mr. President, there is one other detail in which the members might be interested; 11 new applications for membership have been received at the

registration desk during the last three days.

President Dove: Our association year closes on September 30, and that is the date of closure of the treasurer's report and of the secretary's report. The secretary's report will be accepted.

We will next hear the treasurer's report. F. E. Weise.

Treasurer's Report

Cash balance, October 1, 1941.....	\$ 661.10
Receipts:	
Dues	\$1,086.00
Advertising	636.57
Miscellaneous	13.10
	1,735.67
	\$2,396.77
Disbursements:	
Salaries	\$ 668.05
Stationery and printing.....	1,179.50
Office rental, telephone & stenographic expenses.....	229.62
Convention expenses 1941.....	176.84
Social Security tax.....	15.50
Miscellaneous	23.13
	\$2,292.64
Cash balance, September 30, 1942.....	\$ 104.13

Signed—F. E. WEISE, Treasurer.

President Dove: You have heard the reading of the treasurer's report. If there are no omissions or corrections, it will also be placed on file.

The next order of business will be the presentation of the Auditing committee's report.

Auditing Committee

Gentlemen:

We, the undersigned of the Auditing committee, have examined the books of the secretary and treasurer and have found them correct as of September 30, 1942.

Signed:

T. H. Strate, Chairman
M. Meyer
R. P. Luck

President Dove: Thank you, Mr. Strate.

Subjects Committee

President Dove: The next order of business will be the presentation of the report of the Subjects

committee. F. H. Soothill is chairman of that committee.

Mr. Soothill: Your Committee on Subjects recommends to the Executive committee that the following subjects be assigned to committees for study and report at the next convention:

- 1—Salvaging Bridge, Building and Water Service Materials.
- 2—Men—How to Secure and Hold.
- 3—Materials—Possibilities of Relief Through Substitution.
- 4—The Maintenance of Coaling and Sanding Facilities to Meet Today's Exacting Requirements.
- 5—The Cleaning of Pipe Lines In Water Service.
- 6—Securing Maximum Utilization of Work Equipment.
- 7—Revising Working Practices to Eliminate Interference with Traffic.
- 8—Carrying Over Bridges and Trestles.

Signed:

F. H. Soothill, Chairman
A. E. Bechtelheimer

R. E. Caudle
 G. S. Crites
 R. E. Dove
 E. T. Howson
 A. M. Knowles
 M. Meyer
 J. L. Varker

G. S. Crites: (B. & O.): Mr. President, I move that the report of the Committee on Subjects be accepted. . . . The motion was seconded and carried.

Resolutions Committee

President Dove: The next item of business will be the report of the Resolutions committee.

N. D. Howard: (Ry. Eng. & Mtce.): It is with a deep sense of appreciation to the many who have contributed so largely to the success of our forty-ninth annual meeting that your Resolutions committee has drawn up the following resolutions, and we know that it will be with an equal sense of appreciation and pleasure for you to adopt them for publication in the 1942 Proceedings.

RESOLUTIONS

The forty-ninth annual meeting of our association, now drawing to a close, has convened during a period of great stress for our country and its railroads. Our country is at war. To win the war, it is dependent upon its railroads to carry the burden of peak wartime transportation. The railroads, in turn, to meet this responsibility, are dependent upon their employees, including every member of this association, to maintain their equipment, tracks, bridges, buildings, and water service facilities to a degree adequate to any demands that may be made upon them.

It is in this latter respect that our association has a grave responsibility—and an opportunity. Each annual meeting of our association since its organization in 1891 has contributed definitely to the solution of the most pressing bridge, building, and water service problems of the day, and our present meeting has been no exception. In fact, it is probable that at no previous meeting has the program been so closely tuned to the problems facing its members, and the individual reports and addresses more helpful in the solution of these problems.

Wartime conditions and responsibilities have presented new problems also to us as an Association, but our association has accepted the challenge, and under the able direction of its present and past officers is now consummating one of the most constructive annual meetings in its long history. The deliberations of this meeting, helpful as they have been to those present, will go far beyond the walls of this room and be of interest and benefit to bridge, building and water service men scattered widely over the railways of our country and Canada.

To achieve this end, your officers enlisted the co-operation of many persons, men who have contributed generously of their time and ability. It is proper and fitting, therefore, that we, as an association, at this time, express our sincere appreciation to all collectively, and especially to those who have contributed most largely, in one way or another, to the success of our annual meeting.

Be it resolved, therefore, that in meeting assembled, we express

our appreciation to the following individuals, committees and companies for their efforts and co-operation through the year just past:

To those railway executives and other railway officers who have shown a keen interest in the work of our association and who have encouraged and made it possible for so many to be present at this meeting.

To the Rev. Fred Harrison, pastor, Congregational Church, Elmhurst, Ill., for his invocation at our opening session.

To C. E. Johnston, chairman, Western Association of Railway Executives, and associate director, Western region, Office of Defense Transportation, Chicago, for his timely and informative message at our opening session.

To H. R. Clarke, president of the American Railway Engineering Association, and to E. L. Banion, president of the Roadmasters' and Maintenance of Way Association, for the greetings and inspiring messages they brought from their respective associations.

To Ralph Budd, president of the Chicago, Burlington & Quincy system, for his stimulating and thought-provoking address at our annual luncheon on Wednesday.

To B. R. Kulp, chief engineer, Chicago & North Western, Chicago; W. G. Darley, illuminating engineer, lamp department, General Electric Company, Nela Park, Ohio; Edwin M. Fitch, assistant director, Division of Transport Personnel, Office of Defense Transportation, Washington, D. C.; David P. Beach, assistant chief, Maintenance Equipment Section, War Production Board, Washington, D. C.; J. B. Hunley, engineer

of structures, New York Central, Lines West of Buffalo, Chicago; O. G. Wilbur, appraisal engineer, Baltimore & Ohio, Baltimore, Md.; G. E. Martin, superintendent of water service, Illinois Central, Chicago; R. P. Hart, bridge engineer, Missouri Pacific, St. Louis, Mo.; and W. D. Beck, district manager, Car Service division, Association of American Railroads, Chicago, for their timely and constructive addresses before the various sessions of our annual meeting.

To Sam Campbell, Naturalist, and to Mrs. Campbell, for the highly interesting and entertaining program which they presented following our informal dinner on Wednesday evening.

To past-president A. E. Bechtelheimer, bridge engineer of the Chicago & North Western, for his able address summarizing and highlighting the activities of our meeting at its closing session.

To the Pullman Company, for its courtesy in extending half-rate privileges to our members in traveling to and from our meeting.

To Railway Engineering & Maintenance, and to its publisher, the Simmons-Boardman Publishing Corporation, for preprinting our reports, and for making available copies for use by members during our meeting; and

To the officers and directors of our association, and to the chairmen of its committees for the time and effort they have expended on the affairs and work of the association during the last year.

Signed:

N. D. Howard, Chairman
R. E. Caudle
W. A. Batey
W. A. Huckstep

Mr. Howard: Mr. President, your

committee recommends the adoption of these resolutions and their publication in the 1942 Proceedings.

President Dove: Gentlemen, you have heard the reading of this report and the recommendation. What is your pleasure?

... The report was adopted.

Obituary Committee

President Dove: The next order of business will be hearing of the report of the Obituary committee. C. R. Knowles, chairman of that committee is not able to be present and Mr. Weise will read the report.

To the members of the American Railway Bridge and Building Association:

It is with profound regret that we have to report the passing of the following members of the association:

William Curtin, contractor, 2144 Retallock St., Regina, Sask.

H. M. Baker, supervisor, B. and B. Missouri Pacific, Nevada, Mo.

J. M. Derden, Grady, Alabama.

H. A. Nealley, associate, Jos. Dixon Crucible Co., Cambridge, Mass.

F. N. Graham, assistant engr., D. M. and I. R., Duluth, Minn.

Geo. Soughrane, 2815 Pine Grove Ave., Chicago.

F. H. Smythe, supervisor, B. and B., C. & O., Peru, Ind.

F. M. Figg, assistant engineer, C. & N. W., Chadron, Neb.

Geo. W. Rear, engineer of bridges, Sou. Pac., San Francisco, Cal.

George Rear was a past-president of the association, having served as president in 1915-1916.

It is with the deepest sympathy

and reverence that we record the loss of these faithful and loyal members of our association.

Therefore, Be it Resolved, that the members of this association, in convention assembled, express their deep regret and sorrow for those losses, and that as an expression of condolence to their surviving relatives, who also mourn them, this resolution be spread upon and be made a part of the minutes of this meeting, and a copy be sent to the families of these deceased members.

Signed:

C. R. Knowles, Chairman,

F. E. Weise

G. S. Crites

J. L. Varker

President Dove: Gentlemen, you have heard the report of the Obituary committee. What is your pleasure?

Mr. Howson: I move it be adopted.

... The motion was seconded and adopted.

President Dove: In connection with this report, C. R. Knowles, who has known George Rear for many years has volunteered to submit a memorial regarding Mr. Rear for inclusion in our proceedings. (See page 8.)

Report of Convention City Committee

G. S. Crites: Mr. President and members of the association: Your committee appointed to select the meeting place for the 1943 meeting recommends that Chicago be selected as the headquarters for our convention in 1943.

President Dove: Gentlemen, you have heard the reading of this re-

port. What is your pleasure?

A. M. Knowles: I move that the secretary be instructed to cast a unanimous ballot in support of the recommendations.

... The motion was seconded and adopted.

Secretary Shaver: Mr. President, I cast the ballot in favor of Chicago as the convention city for 1943.

Election of Officers

President Dove: The next order of business will be the hearing of the recommendations of the Nominating committee, A. E. Bechtelheimer, chairman.

Mr. Bechtelheimer: This is the report of the Nominating committee:

For:

President, G. S. Crites, B. & O.
First Vice-President, R. E. Caudle, M. P.

Second Vice-President, A. M. Knowles, Erie.

Third Vice-President, N. D. Howard, Ry. Eng. & Mtce.

Fourth Vice-President, J. L. Varker, D. & H.

Secretary, L. Kindred.

Treasurer, F. E. Weise, C. M. St. P. & P.

Directors:

To fill vacancy in term expiring 1943: K. L. Miner, N. Y. C.

For term expiring 1944: F. G. Campbell, E. J. & E.; J. S. Hancock, D. T. & I. and L. C. Winkelhaus, C. & N. W.

Signed:

A. E. Bechtelheimer, Chairman,
Elmer T. Howson

Armstrong Chinn

H. M. Church

C. Miles Burpee

President Dove: Gentlemen, you have heard the report of the Nominating committee. Any member has the privilege of suggesting further names for officers of the association from the floor. It was the intention when I read the names of the members of the committee on the first day of our meeting that you should go to the men appointed to this committee and express your sentiments, but it is still possible for you to make your suggestions. Hearing none, what is your pleasure with the Nominating committee's report?

J. S. Vreeland: (Ry. Eng. & Mtce.): Mr. President, I move that the nominations be closed and that the secretary be instructed to cast the unanimous ballot in favor of the nominations as submitted.

... The motion was seconded and carried.

Secretary Shaver: Mr. President, I cast the ballot in favor of the officers recommended by the Nominating committee.

Installation of Officers

President Dove: Gentlemen, the next order of business will be New Business. You now have the opportunity of bringing any matter before the convention.

Hearing none, the next order of business will be the installation of officers, but before going to that, it may be in order for the president to sing his swan song. I cannot tell you how much I have appreciated the honor that was given me last year. It meant a lot of work and yet the year has gone too quickly. There are many things that I now see that I could have done that I didn't do. Those things you gain only through experience.

And yet what I have done could not have been done without the help of the members of the Executive committee, and particularly of the members resident in Chicago, whom I have called upon from time to time for aid. It is rather dangerous to mention names in order to express appreciation, and yet I do want to refer to the help given to me by Mr. Howson and Mr. Bechtelheimer and Mr. Weise.

I appreciate, too, the fact that all the committee chairmen responded to my request to present their reports in person. Some came at considerable personal sacrifice, others made special efforts to recover from illness and attend. I also appreciate the response of committee members to the questionnaires of the president and of their chairmen. I want you to know that the year has been pleasant and that I have no regrets for having accepted this office. It has done me a great deal of good and I know that the contacts and the friendships I have made are going to prove beneficial and lasting. I hope that the work I have done has been satisfactory to the association, and I assure the succeeding officers and the members of the Executive committee that I will be working with them this next year.

Next will be the installation of the officers. I will ask our good friend and past-president, Elmer Howson, to install these men in their offices. Mr. Howson.

Mr. Howson: May I ask Mr. Church, past-president, to escort Mr. Crites to the platform. And will Mr. Bechtelheimer, also a past-president, escort Mr. Caudle to the platform? Will the other officers elect also please come to the platform.

Before addressing you gentlemen who are about to take on new responsibilities, I want to express a word of appreciation to Mr. Dove, and I think that in so doing I am saying what is in your minds. I know something of the sense of relief that Mr. Dove feels as he lets go of these responsibilities, because 15 years ago today I was in his position at Minneapolis.

This has been a difficult year. It has been a year of launching into war, with the new problems that have confronted every industry and that have confronted the railway industry as well, but you have carried on and have met those problems. The attendance at this convention, the character of the reports that have been presented, and the program as a whole, reflect the effect of your leadership. I know something of the hard work that you have put in because it has been my privilege to work with you, and I know that the association is indebted to you greatly for this leadership. I feel equally certain that they recognize that, and that their thanks go to you. Our congratulations go to you on the conclusion of this very constructive year for this association, and for the railways which it serves.

President Dove: Thank you, Mr. Howson.

Mr. Howson: And to you, Mr. Crites, who are now taking on the responsibilities in a year in which there are many problems ahead, a year of uncertainties—none of us know what the conditions are going to be when we gather a year from now—you have been honored by the highest recognition that is within the scope of the members of this association. And yet the

honor is secondary to the responsibility. This association does not choose blindly when it picks its leadership. It picks men who have been tried, who have served well and who are believed to be capable of further responsibilities. You have been active in this association for many years. You have made many constructive contributions to this organization, and the men know you and they are going to work with you; they are going to accept your leadership this year.

Before handing the gavel to you, I would like to speak also to the men whom the association has chosen to be associated with you. Mr. Caudle, as first vice-president, you, too, are a tried and trusted member of this association. You also have made contributions to its work. The members know you and they know you are going to be a worthy, dependable right-hand man to the president, helping him as he calls upon you, volunteering when you see the opportunities to render further service, and that with the President, you are going to provide a strong team to face the problems of this next year.

And to Mr. Knowles, second vice-president, and Mr. Howard, third vice-president, and Mr. Varker, fourth vice-president, you, likewise, have been honored by this association. But responsibilities have been placed on you, and I like to emphasize the responsibilities rather than the honor. The honor will come; the responsibility is a challenge, and I know that you are going to continue to serve this association as you have done to date. You are going to accept the leadership of the president, work with him and be strong right hands in assisting him in carrying on.

Mr. Winkelhaus, you are a new-comer on this Executive committee. You are going to be asked to work with the Executive committee in facing the problems of the new year. You, likewise, have been tested in this association and I know that you are going to find the association stimulating. You come, as these other men do, from railways which have a long heritage of service in this association, and you are going to maintain that heritage.

Mr. Crites, the responsibility is on your shoulders. We are willing to accept orders.

New Officers Comment

President-Elect Crites: I thank you, Mr. Howson, for these words.

Members of the American Railway Bridge and Building Association:

Our association has bestowed on me the greatest honor that it has to bestow. You will never know how much I appreciate your trust in me. I never expect greater honors.

It is an inspiration to look back at our meetings and recall some of the strong and able men who have held this gavel. Among them are Montzheimer, Hadwen, West, Knowles, Howson, Strate, Burpee, Chinn, Bechtelheimer, Church, and the man who just gave up the gavel, immediate Past-President Dove. Such men are an inspiration to any incoming president. They have labored long and faithfully for our association. May they continue to work long in our vineyard. We need them.

We are in a war which we cannot afford to lose. To do so would mean losing everything worth

striving for. We would lose our association and all similar institutions that are founded upon a faith in a Supreme Being who leads and guides the individual. We are fighting to prevent darkness and despair coming to all mankind. We cannot fail, and the work of our association must be along lines that contribute to success. If republics are to last, associations like ours must work. That means that every member of this association must work harder, not only for his railroad and this association, but also for his family, his church, his lodge, his club, and all such connections that make our way of life the best in the world. First things will come first, but some time should be given to this association, as one will get from the association in direct proportion to what he puts into it, and no more.

We must have new members, because some of us will retire from time to time. It is an inspiration to see the younger men taking an active part on our committees and on the floor. Every member should take it upon himself to see that all who are qualified to become members are asked to join with us. If we do this, our Proceedings will be an inspiration and guide for bridge and building men in the future.

I take pleasure in presenting First Vice-President Caudle to you.

Vice-President Caudle: Mr. Chairman and men of the association, it is a great honor that you have bestowed upon me by electing me to the office of first vice-president of the association, and I want to assure the president, the directors of the association and the members that I shall give the association the best I have during the

coming year. In other words, I will be our new president's top sergeant. If he has anything he wants executed, and will turn it over to me, I will do my best.

President Crites: I have been associated with the next man for a long time. I take great pleasure in introducing the second vice-president, Mr. Knowles.

Vice-President Knowles: Mr. President and members:

I appreciate exceedingly the high honor that you have again bestowed upon me and the confidence that you have felt in my continued activity in the work of the association, and I shall do everything within my power to assist the president and the other officers of the association in carrying out the duties imposed upon me, and shall devote as much time as necessary to the duties of the office. Thank you.

President Crites: Thank you, Mr. Knowles.

Another man with whom I have been associated for a long while, and with a great deal of affection and admiration is third vice-president, N. D. Howard.

Vice-President Howard: Members of the Association, you do me honor each year as you push me one more step up the ladder. I want you to know that I accept this added honor only as it gives me an opportunity to do more for the association.

President Crites: And now we come to a director who has done very ably in that office and who is now promoted to fourth vice-president, Mr. Varker.

Vice-President Varker: I, likewise, consider this election an hon-

or and intend to give my best to the president in his conduct of the affairs of this association during the coming year. I am only too glad to do whatever I can, whenever I can and, with your help, I will continue to do that.

President Crites: I thank you.

Our new director knows what a hard taskmaster I am, for he was assistant chairman on a committee and I made him do most of the work. Mr. Winkelhaus.

Mr. Winkelhaus: It is a new experience for me, but I will gladly and willingly undertake this work. When there is anything I can do, Mr. President, call on me.

President Crites: Is there any fur-

ther business to come before this meeting?

Mr. Howson: I move we adjourn.

Mr. Bechtelheimer: I second the motion.

President Crites: You have heard the motion, duly seconded, that we adjourn. What is your pleasure? All those in favor, signify by raising their right hand; contrary, likewise—it is so ordered.

And now, exercising the powers vested in me as your president, I declare the 49th Annual convention of the American Railway Bridge and Building Association adjourned.

... Final adjournment was taken at 4:56 p.m.



Dismantling a Bridge on the Linwood-Hastings Line
of the Chicago & North Western, in Nebraska.

COMMITTEE REPORTS, TECHNICAL PAPERS AND DISCUSSIONS

Preventing Accidents Among Bridge and Building Employees

Report of Committee

Committee—E. H. BARNHART (chairman), div. engr., B. & O., Garrett, Ind.; W. A. BATEY (vice-chairman), sys. br. insp., U. P., Omaha, Neb.; L. D. GARIS (vice-chairman), asst. gen. br. insp., C. & N. W., Chicago; J. E. BIRD, b. & b., insp., N. Y. C., Corning, N. Y.; W. W. GAINES, br. insp., C. & O., St. Albans, W. Va.; A. G. DORLAND, asst. engr., E. J. & E., Joliet, Ill.; C. C. EUBANK, rodman, C. & O., Huntington, W. Va.; K. HALLOCK, supv. b. & b., C. & N. W., Fremont, Neb.; G. H. HOLMES, supv., b. & b., M. P., Falls City, Neb.; E. H. JOHNSON, div. engr., C. M. St. P. & P., Miles City, Mont.; W. E. MALEY, mast. carp., B. & O., Punxsutawney, Pa.; C. O. SATHRE, asst. b. & b. supv., C. & N. W., W. Chicago, Ill.; J. W. SECKER, sys. bldg., insp., C. M. St. P. & P., Chicago; H. E. SMITH, engr. mtce., G. H. & H., Galveston, Tex. and W. A. SWEET, gen. for., A. T. & S. F., Newton, Kan.



E. H. Barnhart
Chairman

Safety is no new undertaking for the railroads. Early in this century some of the more important systems recognized with considerable concern the mounting lists of injuries and fatalities. At that time it was thought that railroad em-

ployment was particularly hazardous and that if someone lost a leg, an arm, or an eye, this went with the job.

Large industrial organizations were among the earliest to feel the necessity for safe workmen and long before this was generally recognized on the railroads, some industries had skeleton organizations to deal with such matters. While train service em-

ployees were the first to claim attention, owing to the more hazardous positions in which they might find themselves, shop and maintenance of way employees were gradually brought into the picture.

Accidents Taken for Granted

Early in accident prevention campaigns, the prevalence of accidents was recognized. Seldom was a train operated, a gang organized, or an engine serviced that it did not result in injury to some one. Accidents were taken more or less for granted and if one didn't get injured, he was regarded as lucky.

Safety campaigns have shown how fallacious this conclusion was. One of the first methods used in "no accident" campaigns was to list the accidents occurring during a given period, classify them, and endeavor to assign a cause or reason for each. Soon it was discovered that this was a tremendous task, particularly on properties which extended over a thousand or more miles, so district or division committees were formed. The special

advantage of these small groups was personal contact with those injured. One of the primary objects in accident prevention is to obtain the facts in the case. Necessarily, to do this, quick contact is required. One's neighbor or friend working with him in the gang, the crew or at the bench, is in far better position to obtain the facts more quickly than anyone else. Hence we have the origin of worker representatives on safety committees.

Three "E's" Essential

As safety campaigns got into full swing, it quickly developed that, like the three "R's" in the little red school houses, three "E's" were essential if safety were to obtain a firm footing. First—"Engineering"—the car, the locomotive, the tool, the machine, the building, the platform—should be so safe, so guarded, or sufficiently removed from the operated track to prevent an accident. This is where the management functioned. It is surprising how many conditions of these classes were found and corrected on the American railroads.

Managements willingly co-operated with employees to bring about safe working conditions. Not all, were, or could, be corrected, but a very small percentage remained and these were covered by precautionary measures. So thoroughly did managements enter into the spirit of correction that often many thousands of dollars were spent to secure results. Even today after more than 40 years of pioneering along this line, we still find unsafe conditions, which are corrected as they are found.

The second "E" has to do with "Education." Efficient workmen must also be safe workmen. They go hand in hand. To make a safe workman we must not only educate him along the line of his individual work, but must

teach him how to do that work safely, for if it is not carried on safely it is not efficient.

The third "E" is "Enforcement." Safety rules must be enforced, not necessarily by drastic methods such as loss of time or discharge, but by ability to make an efficient, safe and suc-



"The Responsibility for the Safety of Workmen Rests Heavily Upon the Foreman"

cessful workman out of an apparent failure. Think of the possible influence on a gang by a foreman with such ability.

Can We Prevent Accidents?

Prevention of accidents has been discussed as long as safety—but can we prevent accidents? Some say that accidents run in cycles. One territory will go for several months, or even years, without an accident, then suddenly, there will be a veritable epidemic of accidents. To what is this attributable? Whose responsibility is

it? Let us go back and apply our three "E's." Certainly, if the management furnishes safe equipment, tools and machinery, it is not its responsibility. But the management is made up of human beings—our immediate superiors and those higher up. If the bosses are interested in safety, that interest, and to just that extent, will filter down to the humblest employees. So it is the officer's duty to show to employees his intense interest in safety and to insist upon safe and sane methods among them. It should not be forgotten that one unsafe man in a gang jeopardizes the lives of the whole gang. If this employee is not amenable to discipline, or will not practice safe methods, the responsibility rests with the officer to take such steps as will make the gang safe. Constant vigilance should be the rule of the officer. Safety should be uppermost in his mind and he should not hesitate to call it to the attention of his employees at all times.

Foreman Has Large Responsibility

The responsibility for the safety of workmen rests heavily upon the foreman or direct supervisor. His is the largest responsibility in the enforcement of safety of any—outside the individual himself. If he is not constantly on the alert to detect and correct unsafe practices, an accident will soon result. The gang or shop that has the best safety record is that gang or shop where the foremen are safety-minded. This does not only mean that the foreman is safe individually, but that he is always talking and inculcating the habit into the minds of his men. The major responsibility of the foreman then lies in the education of his men along safety lines. This is particularly necessary at the present time when so many new and younger men are being employed. Older em-

ployees should be familiar with safety methods and have enough experience to practice such methods.

The management has certain safety rules which are to be obeyed. These rules are the result of bitter experience, for it is said that each one of them is written in some fellow-worker's blood. They were made rules in order to prevent a reoccurrence of the accident or accidents which resulted in the rule being promulgated. The foreman should be going over these rules constantly with his men, for it is only by continued repetition of such rules that they become fixed, and when fixed they become a habit. The newer and younger employees should especially be required to adhere strictly to these rules. The younger employee pays close attention, if he is interested in his work, to his fellow employee. If he sees that employee breaking one of the rules on safety and the foreman passes it without calling his attention to it, the work of perhaps weeks or months of education along safety lines is destroyed. The foreman should not permit even the slightest infraction of a safety rule, for if he does, he has lost a valuable asset in safety education.

Wholehearted Co-operation

In addition to the printed safety rules now almost universally used on the railroads, other bulletins and instructions are issued from time to time. How are these new instructions to be gotten before each man? The foreman is the only one to bring such instructions to the attention of his gang. Some foremen do this in a rather matter-of-fact way, and when they have done this they feel that they have completed a disagreeable task. How much attention do you think is paid to such presentation? How would it impress you if you were a new

man? To bring any instructions forcibly to the attention of a gang, such instructions must have the whole-hearted cooperation and sympathy of the foreman in charge, and he must be able to impress upon the men the importance and necessity of complying with such rules.

Advice to the New Man

The foreman must be a leader and of such a personality as to impress his men. The younger men especially look to and admire leadership. The foreman who is a leader can hold his men, can obtain greater efficiency from his men, and can do work more safely than a weaker man. After all, efficiency and safety go together, for if work is done in an unsafe manner, it is not efficient, and, on the other hand, if the work is performed efficiently, then it is usually safe. More attention should be paid to new men entering the service, endeavoring to educate them along safe lines. One method of doing this is the practice on one road on which the new man is given a printed form in duplicate, which he is required to read, sign both copies, and retain one. The form contains seven paragraphs and it is so pertinent that it is reprinted here:

(1) Your success in the service you are about to enter will depend upon the care you exercise in the discharge of your duties. The best record you can make, both for yourself and the company, is the record of a careful and safe man. You are not expected to take any unnecessary chances in the performance of duties.

(2) The problem of safety is not altogether a question of rules and their enforcement, safety appliances and their application; but the development of inherent, self-restraint and control. Safety is fundamentally a habit of mind which may be acquired by all through the exercise of ordinary caution and forethought in the small details of everyday duties.

(3) Safety must be the first consideration of every employee. Only employees

who are thoughtful of the safety of themselves and others will be retained in the service. Those who violate the rules, or are careless will be discharged.

(4) Foremen will be held responsible for seeing to it that all persons applying for work receive and thoroughly read a copy of the safety rules and instructions before entering the service.

(5) When you accept employment or remain in the service, it is understood that you do so with the full knowledge of the hazards of railroad work, and that you agree to exercise due care in the performance of your duties to prevent accident or injury to yourself or others.

(6) You are required to report violations of the rules, as the safety of yourself and fellow-workers depends on their observance.

(7) Don't take chances! Remember to be careful under all circumstances. When caution becomes a methodical habit, there will be few injuries. Prevention of accidents is one of your most important duties. It is better to cause a little delay than to cause an accident, the memory of which may live with and distress you throughout the years to come.

Rule-a-Day

Another railroad has the following safety slogan: "Obey the operating and safety rules and you'll never get into trouble."

It is the practice on some roads, in order to keep the safety movement constantly before their employees, to designate one of the rules for each day—known as "Rule-a-Day." This particular rule is posted on bulletin boards, in shops, rest-houses and dormitories and read to gangs before the start of each day's work. The interest of the officer in seeing that this is done is paramount in the success of any such practice. Officers are too prone to have the instructions issued, and then promptly forget them. If the officer, when going through the shop or out on the train, or with a gang, does not take enough interest to ask concerning the safety rules, this

practice will soon be discarded.

The measure of practically all work or successful practices today is by comparison. The units by which we judge efficiency and economy are by comparison. We compare one man with another, one division of a railroad with another, one gang or one shop with another. Local safety com-

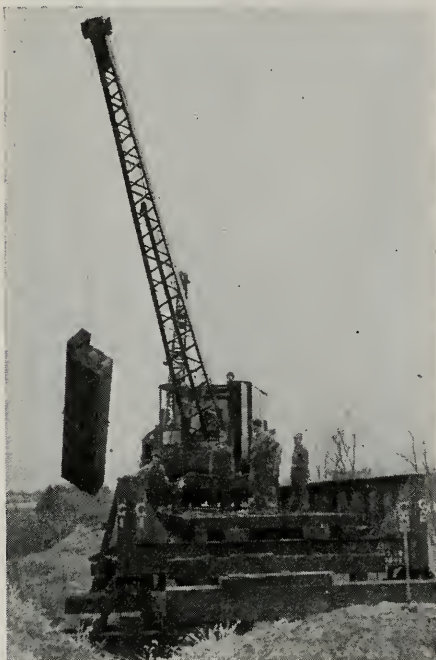
mittees, while probably not in direct violation of any specific safety rule, did result in an accident, and thus possibly prevent a reoccurrence of a similar accident. Talks during noon hours at the shops or at specially appointed safety rallies serve to keep constantly before the men the importance of the safety movement.

Physical Examinations

During these days of difficulty of obtaining men and consequent loss of experienced men, the question of the physical examination of employees before entering the service is a live one. Some roads have waived or are now considering waiving such examinations in order to obtain the necessary help. There are two primary dangers in such action—first, the very real probability of bringing into railroad service men with seriously diseased minds or bodies, who will prove a grave set back to the safety movement—and second, the possibility of suits against the company in efforts to secure large sums of money.

The close observance of the old, but ever true, saying, "A sound mind in a sound body" was never more necessary than it is today. Railroad work in nearly all departments today is hazardous at the best. This is more particularly true in the bridge and building department where work now must be done with machines and under considerably increased traffic. It requires the mental alertness of every individual and correct planning by the foreman. One who has a mind dulled by disease, or other causes, has no right to jeopardize his fellow employees.

Home conditions, too, play a large part in the man's attention to his work. If the employee has family troubles, he cannot help but carry them, to a certain extent, to his work.



Handling Heavy Bridge and Building Materials Safely Requires "Team Work"

mittee's work, too, is compared with that of other committees, and thus sharp competition is set up which often produces good results. So it is very conducive to the safety movement to co-ordinate the activities of the various local committees and arouse a spirit of competition and strive to obtain the best safety records.

The primary work of the safety agent should be directed along these lines. He can show how certain prac-

Under present day conditions it is imperative that each individual have his mind 100 per cent on his work. This is doubly true of the foreman, for he has not only the responsibility of planning the work, but also of seeing that each individual understands just what his part of the work is and when he is to function. Too many accidents have been caused by improper team work or ignorance of the sequence of the various steps in the operation.

All labor organizations and a vast majority of employers have long recognized that man is not a machine. To do his most efficient work safely, he must be alert and quick to make decisions. The man who is dulled by fatigue or near exhaustion is a menace to the company as well as to himself and his fellow employees. Long hours of work, producing fatigue, have therefore, long since been recognized as a detriment to good work. In emergencies, such as floods, fires, etc., necessary provision should be made for rest periods to avoid the possibility of serious accidents.

Handling Materials

The handling of materials constitutes a large part of the work of the bridge and building department. Usually these materials are large and heavy, requiring special tools, machines and knowledge of handling. In this special task, "team work," more than anything else, is required. So many accidents in handling materials are traceable directly to misunderstanding among the men as to how the material is to be handled, when and how to take hold of a piece of timber and when and how to let go. Here is where the wide-awake, alert foreman comes in. This becomes one of the particular duties of the foreman in handling men properly.

When heavy material is being handled, the foreman should be with his men to direct them and to be sure that every man understands perfectly his part in the operation. Some gangs have acquired that perfect team work so essential in doing this work, that they go along day after day without an accident; others have accidents almost every time they are called upon to handle material. This in large measure is chargeable to the foreman and he should recognize his responsibility in this respect.

Other Causes of Accidents

All roads require safe tools as a prerequisite to good work. Here again it is the foreman's direct responsibility to see that the tools his men are using are safe. This requires almost daily inspection of those tools, particularly those having striking faces. Inspection of the handles of all tools to see that there are no broken, split, or cracked handles which might cause injury is essential. Tools with sharp edges should receive particular attention so that they will be in shape for proper use. A dull tool can cause an accident, either to the user or his adjacent workmen. So many operations today, especially in steel work, make it mandatory to use goggles as protection for the eye that entire gangs should be so equipped. The foreman should see that he has the proper number of goggles and that the men wear them in operations that might cause an eye injury.

The breaking of cables, ropes and hooks is another source of potential injury. Ropes that are allowed to lie around on the floor or other damp places for a long time and are then used for scaffolding are very likely to cause injury. Ropes, when carried as part of the equipment, should receive special care, and after they are

old they should not be used where they are required to support men. Inspection of wire cables is very important. A broken strand or two is an invitation to an injury if it is required to support weight. The manner of constructing wood scaffolding is a potential cause for accident. Inspection of the support boards for wind shakes, knots, etc., is very important.

Shields and screens to prevent workmen from getting caught in moving parts of machines are almost universally provided. There are conditions, sometimes, where such safeguards are not provided. Foremen should caution workmen using machines under such conditions, for by this means, injury may be prevented.

Bridge and building men are often called upon to use inflammables and explosives. Practically every railroad has rules devoted to the safe manner in which such materials should be handled. If these are not known to the workman, or he has not handled such materials for a considerable period, he should familiarize himself with these rules before attempting to handle these materials. The foreman should see that the employee does know how such things should be handled.

Again, bridge and building employees are often called upon to work along heavily traveled highways; at crossings involving these highways; in connection with the erection of high-tension power lines; or in supporting traffic in connection with highways. Too much stress cannot be laid upon the grave responsibility of the foreman in planning and carrying out such work. Barricades and flagmen are quite often necessary to protect the gang properly. Alert, intelligent men from the gang who are thoroughly familiar with the operating rules should be selected as flag-

men. Even by such selection, the foreman's responsibility does not end, for he should instruct the man in detail how to do the flagging and make him repeat these instructions to satisfy himself that the flagman understands what he is to do. Many near-accidents have been caused by flagmen not being properly instructed before they are sent out. The employee selected to do the flagging should also recognize his responsibility. Sometimes the lives of the entire gang are entrusted to him. If he is not absolutely certain of all the details required of him, he should not undertake the job until he is sure. This is particularly true in floods, fires, sinks or other catastrophes which may put the track or tracks out of service, or necessitate a very material reduction in the normal speed of trains.

To those who are intensely interested in the causes and prevention of accidents, aside from those directly concerned with the safety movement, the question often arises whether there will ever be a time when we can develop and remove the causes of all accidents. So long as the human element is involved in such accidents, it seems hardly probable that we will attain complete perfection. Only by constant application and attention to our work can we hope to minimize and reduce the causes for accidents to as near zero as possible. The safety movement is a constant, continual and every-moment proposition. Interest in it cannot be relaxed for a single moment, or we may find ourselves reducing to zero the work of months and years of education and vigilance.

Conclusions

While the safety movement on the railroads is of comparatively recent origin, certainly within the present

century, statistics prove that its development has been a profitable undertaking. The railroads have secured more efficient and better work owing to the conservation of trained manpower, thus resulting in the more efficient execution of work and consequent increase in net revenue from the property.

From the worker's point of view, it has proved more than profitable, resulting in continued and constant employment under much better working conditions, thus permitting him to better provide for his family, and thereby assist in raising the American standard of living.

Then, too, the State has a vital interest in the movement and has profited tremendously thereby. The family of the fatally injured employee often becomes a subject of public charity or dependent upon the State for sustenance. The large reduction in the number of fatal accidents, or loss of arms, legs or eyes which can be traced to safety campaigns has resulted in less public charity.

Safety is a two-fold problem—management and men. Unless officers are constantly and continually interested in the safety movement, it will lag, resulting in an increase in accidents. Primarily the heaviest responsibility rests upon the individual and the direct supervisory officer—the foreman. No other one person can do more to promote safety and bring accidents to the much coveted goal—Zero—than the foreman. He can even do more than the individual, as a slip-up by him may result in injury to several in the gang. In planning the work, in handling materials required in carrying out the work, and in the actual performance of the work, he should be wide-awake and “on the job” every minute. The foreman must also be a leader and have such training that the men will recognize his

ability in leadership. In the final analysis, the individual workman must be intensely interested in his own work so that he will *want* to do his work safely and efficiently, and in such a manner that there will be no injury to himself or his fellow workers. Education of the individual by the foreman so that the safe manner shall become a habit with the workman, and constant stressing of safe methods, are the two main essentials of producing “no accidents.”

To obtain the best results in preventing accidents in the bridge and building department, as well as all other departments of the railroad, every employee, supervisor and officer should subscribe rigidly to the four following simple statements.

(1) Obey the rules and regulations of the railroad.

(2) Safety is of FIRST importance in the discharge of duty.

(3) Obedience to the rules is essential to safety.

(4) Use extreme care in every detail of work to prevent injury to self or others.

If every individual will follow these four rules faithfully and rigidly in all of their minute details, and to their fullest interpretation, the goal of every safety campaign—Zero in accidents—will be attained.

DISCUSSION

G. S. Crites (B. & O.): I want to repeat a tribute I heard paid to this committee. One of the committeemen, upon receipt of the draft of this report, brought it to me and said, “I believe this is the most able discussion on safety for bridge and building men that has ever been put out. I would like permission to circularize it among my foremen and men. I do not think anything better on safety will ever be printed.”

President Dove: Thank you, this is a very fine compliment. We have heard a well prepared and well read report. This particular subject was selected for the lead-off report because it is a subject of great importance and one in which you are all very well versed.

Armstrong Chinn (Alton): Mr. Crites beat me to the gun and made the remarks about this report which I had intended to make, but I want to endorse all Mr. Crites had to say. I think this is a most excellent report and a very timely one, and I believe that if every bridge and building employee would read it and act on its suggestions, we would not have any more accidents in the bridge and building department.

I think the report is timely for two reasons: First, because these are war times, when manpower is scarce, and we should do everything we can to conserve the manpower remaining on the home front. Every man-hour we lose because of an accident is simply a man-hour lost forever, because we have no other employees to take the place of men lost through accidents. Second, because no matter how we view the war situation, we are all working under more or less stress. Many of us have relatives and friends, even sons, and some of us daughters, who are serving with the armed forces, and we are quite naturally thinking about them and their welfare. When we have such thoughts on our minds while at work, we are possibly not thinking as much about safety as we should. On the other hand, the report brings out the necessity of thinking safety constantly while we are working.

Sometimes I think we stress

safety-thinking too much and not enough danger-thinking. When a man feels so safe in his occupation and thinks he is surrounded with so many safety devices that there is nothing left for him to worry about, he quits thinking about safety. He feels everything is all right, and there is nothing left for him to do. This is when an accident catches up with him. Sometimes I think we should put more stress on danger-thinking; that is, the danger of the work we may be doing, because I do not believe there is a man alive, in his right mind, who wants to get hurt. So far as the individual is concerned, when he gets hurt, it is purely and simply an accident. But usually he gets hurt because he is not thinking about what he is doing.

The report brings this out clearly in a couple of places. In one place, speaking about the foreman, it says: "This does not mean alone that the foreman is safe individually, but that he is always talking and inculcating the habit in the minds of his men." It also says: "For it is only by continued repetition of such rules that they become fixed, and when they become fixed, they become a habit."

I think you will all agree that every man is born with what one might call a safety instinct, or the instinct of self-preservation. He wants to protect himself; he does not want to get hurt. He wants to live, but is not born with the knowledge of how to provide or to surround himself with safety. This comes only through education and instruction, and the individual must go along with this educational program until he becomes safety-conscious, or until

the safety habit becomes fixed. In other words, until he has thought about safety and worked safely for so long a time that he does the safe thing naturally, or until it becomes automatic, like driving an automobile. After a man has once learned to drive, he no longer has to decide which pedal to press when he wants to stop, or how to start or steer the car. These things are performed automatically, and I believe that when a man has been taught safety long enough and has had it drilled into his mind often enough, he will become safety-conscious to the extent that safety will be second nature with him. Only then will he become a safe worker.

L. D. Hadwen (C. M. St. P. & P.): What Mr. Chinn has so ably expressed brings to my mind a phrase which I think is quite apt—that an accident is the result of confusion of thought. In other words, men get rattled. I believe that we must instill and train men to think clearly about safety to meet modern conditions. The more we train a man in this respect, the safer he will be.

President Dove: Quite true.

L. D. Garis (C. & N. W.): There is one thing which could not be incorporated in a report of this kind very readily, and that is mention of some of the more controversial phases of safety. During this last season I brought this subject of safety up at several dinner meetings, and found plenty of things about which there is considerable disagreement.

At one of these meetings in conversation with one of our oldest claims agents—a man who was associated with Mr. Richards in

the early days of the safety movement—he said that, to some extent, we were slipping; that this emphasis on the foreman and the men was being overdone. He said that the fellow he would like to see held responsible is the supervisor; he suggested that we list our supervisors, and show how many accidents they have each month, keeping the score to the end of the year. He would then rate the supervisors, putting the one who had the least number of accidents at the top of the list, and the one with the most accidents at the bottom. No supervisor would want to be at the bottom of the list, and would, therefore, get out and see that his foremen and men worked safely. I do not know whether I agree with him, but these were his sentiments.

There is another phase of safety which has always impressed me, and that is the psychological phase of it, which Armstrong Chinn covered so well in his recent article in *Railway Engineering and Maintenance*. However, Mr. Chinn made no direct mention of the matter of hearing and sight in connection with safety, factors often referred to by psychologists. When a person sees a bright light he shuts his eyes automatically. When he hears a loud noise, he jumps. But these reactions are of little avail in the presence of our new streamlined trains, which are about the most noiseless things on wheels.

At Waukegan, Ill., we have what is known as "Graveyard curve." The curve has a badly obstructed view and is in a territory of whistle restrictions. One day I had my motor car off in the vicinity of this curve, when a stream-

liner slipped up on us without being heard. No one was aware that the streamliner was coming. This is certainly something which should be taken into consideration.

Motor cars present another very controversial subject. A motor car is certainly a tremendous responsibility. I tell my bridge men when they start out with me, "When you get on this motor car you are flirting with the angels, and if you do not watch out you are liable to become one." I have heard it said that it would be quite simple to wire motor cars so they will throw signals. I think this is probably the most impractical idea that I have ever heard, but I have found many supervisors in favor of it. No doubt this has been considered and ruled against, but it is a matter concerning which we should not be backward in expressing our opinion.

President Dove: I think you are quite right, Mr. Garis.

Mr. Crites: I am afraid that the claim agent with whom you were talking was not very familiar with the safety record of bridge and building men. On many roads there are gangs that have no accidents for days, weeks, and even years, so all of those gangs would head the list. I do not know where one would put them if they tried to list all of the gangs according to their safety performance.

A good practice is to give a foreman a card designating that he has had an outstanding safety record for one, two or three years. For one year, the card should probably be signed by the bridge and building supervisor; for two years, by the superintendent or division engineer, and so on. If a foreman has a record for a number of years,

he should get a card of commendation from the president of the railroad. I do not think the claim agent referred to had a proper picture of how bridge and building foremen are handling safety.

Mr. Garis: On the C. & N. W., a supervisor has many foremen under him. Our system claim agent told me that this plan is used on several railroads.

Mr. Chinn: There are two or three more comments I would like to make. The first has to do with the three "E's" cited by the committee. The first "E" covers engineering—in other words, the work of providing safe tools and safe working conditions. The second "E" has to do with education, and the third "E" with enforcement. In most of the safety talks and meetings I have attended on my railroad, and on some others, I think that too much stress has been laid on the first "E"—the engineering, or the safety of tools and working conditions—and not enough on education. Over a period of years—since we established and have been following a safety program—almost everything we could do so far as engineering is concerned has been done, but we are still sadly lacking in so far as education is concerned.

In checking over accidents for a long period of time, I find that about 15 per cent are due to unsafe tools or unsafe working conditions, and that 85 per cent are due to man failure—lack of education. So it seems to me that we should stress that part of the problem which is the source of most accidents. As I said before, if we can educate our men so they will do the right thing in-

stinctively at the right time, they will not get hurt. On the other hand, if we surround men with so many safety devices that we stifle their safety consciousness, we are certain to get them ripe for injuries.

I do not know whether you have looked over many personal injury reports, but probably 80 or 90 per cent of the reports I have seen begin with these statements on the part of the injured person: "I did not think that so-and-so was there"; "I did not think the tool was dangerous"; "I did not think there was a rock in the way"; "I did not think I was going to fall." These statements say a little too much. They should say simply, "I did not think—period." If we can find some way to make our men think clearly, they will not get hurt.

President Dove: Another thought which occurred to me during the reading of this report concerns the "Rule-a-Day" practice on some railroads. For this practice to be really effective, it must be followed up by officers as they go around—not just in one place, but wherever they happen to be.

W. A. Huckstep (M. P.): I would like to inject a thought which I think is probably timely, because of the war and the possibility of sabotage. On all railroads today, we have fire extinguishers. These are easily subject to sabotage. I am thinking particularly of the soda-acid type of extinguishers, which can be damaged by pushing a piece of chewing gum into the nozzle of the hose and thus obstructing the flow of fluid. If this should be done, the extinguisher is liable to explode when it is opened for use, because the pres-

sure builds up rapidly and must be dissipated somewhere. Another thing is the importance of replacing the rubber hose on fire extinguishers when they are in poor condition. These hose should be inspected periodically.

In recharging extinguishers, one should exercise extreme care. There is real danger if the nozzle becomes blocked. If one does not know what precautions should be taken in the discharging of an extinguisher and finds the nozzle stopped up, he should cut the hose to relieve the pressure, or use an axe to cut the tank. If he cannot do either of these things, he should get away from the extinguisher as quickly as possible, because it may blow him to "kingdom come." I have knowledge of several such accidents that were quite serious.

According to the Underwriters, most accidents with fire extinguishers occur when their orifice is blocked. It would be well to remember this and to inspect fire extinguishers closely, especially those which develop high pressure and are subject to bursting or exploding, if they are not functioning properly.

President Dove: A very good point, Mr. Huckstep.

L. G. Byrd (M. P.): I am very much interested in that part of the report which refers to new men. My experience is that we have more trouble with our older, experienced men, than with our new men. Why that occurs, I do not know exactly, except that possibly we do not continue to follow up our older men with our educational program, or keep them informed as to the danger of the work they are doing. I do not know how other supervisors on

the Missouri Pacific handle the employment of new men, but when I hire a man, I go over the subject of safety with him personally, and explain to him that his most important duty in performing his work is that of safety.

For the last four or five years, we have had more trouble with the men who have been in our employ for 10 to 15 years than we have had with those who have been with us for only six months or a year. We should follow up with the older men continually, as well as with the younger men.

Going back to what Mr. Huckstep said about fire extinguishers, I believe he left out one important precaution which should be taken in their care and handling. One should note carefully that the cap on top of the water container is sealed, and that the water has not been replaced by gasoline or other inflammable fluid. If the cap is properly sealed, it cannot be easily removed for the substitution of dangerous fluids in place of water. Recently we found that some of our caps had been removed. We do not know whether they had been tampered with purposely or had been removed by someone who did not know what he was doing. Also, the hose of some of our fire fighting equipment had to be changed. Some of this had been folded up instead of being rolled up on a reel and connected where it could be used immediately in case of fire. A periodic inspection of the hose is very important.

One thing has greater bearing than anything else in preventing accidents. That is the training of our men, not only those in the bridge and building department, but trackmen, trainmen and every-

one else. It is the duty, for example, of every officer and employee to caution other officers and employees, whether they are in their particular branch of the service or not, as to how to do a good job of flagging, and when they should flag. We have been hiring so many new men that we have not had the time to educate them in proper flagging and in the carrying out of other details of their work. On the Memphis and Missouri divisions, we are all taking a vital interest in educating our employees, not only in proper flagging, but in all of their other duties.

President Dove: Thank you, Mr. Byrd, your remarks support the second idea referred to by Mr. Chinn.

Mr. Chinn: I want to tell a little story that bears out what Mr. Byrd has said about our older employees getting hurt. Back in 1933, when the depression hit us pretty hard, we put some extra gangs out on the track to fix up our railroad for some of our high-speed trains. These gangs included a lot of our carmen and trainmen, who were unemployed at the time. They had never worked on the track, and knew only little about it, but they wanted to get in the gangs. When we hired the men, I said to myself, "There goes my safety record." They were given safety talks when they started to work, but more important, because the work was new to them and they were not at ease, they were constantly on guard and watching what they were doing. As a result, we did not have a single accident in those gangs. But the older men, who thought they knew all about it and were comfortable, and therefore

had nothing new to watch out for, were the ones who had the accidents. So I want to emphasize what Mr. Byrd has said—that safety education should continue with our older men as well as with our new men—because, when an older employee gets to the point where he thinks he knows all about the work and does not have to worry any more, it is then that he is getting ripe for an accident.

President Dove: Why is it that the older men are adopting this apathetic attitude toward their rules? It would seem to me that maybe there is something wrong with our method of education; that we do not know how to present safety to them in a way that is really effective.

Mr. Chinn: It is not that at all. It is just a characteristic of human nature. After you have done the same thing over and over, you do it without giving it very much thought. When you walk you do not stop to think that you must pick up your left foot and put it in front of your right foot. You just do it. It is the same when you drive a car. After you have learned, you do not think about it. These men, after they have done the same kind of work year after year, do it without consciously thinking about it. So our educational program, as I see it, must be along lines that will keep these men mentally alert, and, whether they want to or not, thinking about safety.

You do not have to be driving at a man all the time to make him think about something. I have in mind, for example, the use of safety posters. He sees the message they carry. His attention is not forced to it, but he sees it, and

the thought that it carries enters his mind, and subconsciously does its good work,

I think the "Rule-A-Day," mentioned in the committee's report, is a pretty good idea. It only takes a minute or two, and it does not bore the men. While it may apply to only one particular thing, nevertheless, it gets their minds in tune with safety, and they, subconsciously, think about it during the day.

It is pretty difficult to keep talking to men about the same thing day after day, and not get them to the point where they are so bored they do not want to hear anything more about it. We must find ways to stimulate the men's interest every day. If you should say to one of your men—"Well, Joe, you are going to have an accident today; you are going to be badly hurt," Joe would be doing some quite serious safety thinking all that day. It is when Joe does not think that he gets hurt.

President Dove: That is right. We want the men to get in the habit of thinking safety.

Mr. Byrd: The "Rule-A-Day" is not only our practice, but we have instructions from our management to put out a special rule every day, and that rule is to be read before starting the day's work. This applies not only to maintenance of way employees, but to all employees.

In addition to the rule a day, which is put out by the division engineer or superintendent, the foremen of the bridge and building and water service gangs on the division with which I am connected are requested to pick out each day a rule pertaining to the particular work they are to do.

The foremen also ask their men to pick out some rule which they feel will help prevent an accident in their regular daily performance. We have found this practice to be very worthwhile.

In addition, we also appoint in each gang what we term a safety captain. He generally picks out the rule for the day and cautions the men. He also watches them for one week to detect any violation of safe practices. At the end of the week, another man is appointed to take his place.

The reason I mentioned injuries to older men is that during the last 19 years, for which period I have the record, about 90 per cent of the injuries have been among those men with from 5 to 18 years service. During the last four years, among 10 gangs on the Memphis and Missouri divisions, we have had four reportable injuries among men who have been in service from 15 to 20 years, with no reportable injuries among the men in service from 1 to 5 years.

Mr. Crites: Mr. Chinn talked on the psychology of accidents. This is a little deep for me, but an analysis of accidents usually shows there has not been a clear understanding among those involved. In the case of the newer gangs, the foremen, because the men are not entirely familiar with the work, must assign the men to their tasks very carefully. They know the hazards they are liable to run into, so they protect the new men, and try to have the work done in a uniform manner.

I think too much has been said on the psychological point of view and not enough on having a clear understanding of the task to be done, how it is to be done, and the

organization that is to do it. The foreman must not take it for granted that the men know exactly what they are to do, when they are to do it, and how they are to do it.

G. V. Coffey (M. C.): I believe that all railroads make investigations of accidents involving three or more days lost time. Most roads make formal investigations of accidents involving any loss of time. I understand that some of them now investigate all accidents, whether they involve lost time or not. I should like to ask Mr. Barnhart if, in compiling his report, he learned of the reaction of the men—either in the decrease of minor accidents or increased attention to safety—as a result of these formal investigations of minor accidents?

Chairman Barnhart: I do not believe I can answer that because, so far as I know, very few minor accidents are investigated in the same manner as reportable accidents.

While I have the floor, may I comment on the discussion regarding the relative number of accidents among older men and newer men. I think it is a serious reflection on the ability of the foreman when the majority of accidents occur among our older men.

G. H. Holmes (M. P.): On our road, the immediate supervisor over the workman makes an investigation of every accident. While I do not have records to prove that this helps, I believe that it does quite a bit toward avoiding accidents and injuries.

President Dove: I think this closes the discussion, so we will dismiss the committee with the hearty thanks of the association for a splendid piece of work.

Outlook for Labor in Bridge, Building and Water Service

By Edwin M. Fitch

Assistant Director, Division of Transport Personnel,
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E. M. Fitch

Unfortunately, the manpower problems with which you were confronted a year ago foreshadowed only dimly the problems which confront you now. The most drastic change in this respect has been brought about by the growth of our military establishments. Last year you had no need to be particularly concerned about the operation of the selective service act. This year it is one of your major manpower problems. Last year you had no personnel shortages that were worth bothering very much about. This year you are faced with serious shortages among certain skilled workers and, in some sections of the country, those shortages are even extending to common labor. Last year, women in overalls tended to be the exception. This year, women are the principal hope of expansion in a great many productive enterprises.

In July of this year there were between 40,000 and 45,000 employees in the bridge, building and

water service departments of Class I railroads. Of these, about 13,800 were bridge and building carpenters, 3,200 bridge and building painters, 900 bridge and building iron workers, and 3,900 bridge and building gang foremen of skilled labor. There were 4,200 employees who were operators of portable steam equipment and 1,900 pumping equipment operators. And, finally, there were 8,900 helpers and apprentices, some of whom were in maintenance of way, but the majority of whom were in the bridge and building department. From the manpower standpoint, the important thing about these employees is that the vast majority are skilled workers or skilled trades helpers, because it is among the skilled trades, for the most part, that the greatest difficulty is being found in securing additional employees.

Recently the Association of American Railroads undertook a survey of personnel needs and training facilities among Class I railroads. The returns indicated that the Class I railroads, on September 15, needed about 5,000 men in bridge, building and water service occupations. This number of unfilled vacancies is equal to nearly one-ninth of total bridge, building

and water service employment as of the last month for which figures are available. This situation is serious enough. Moreover, the personnel shortage situation is likely to become worse unless strenuous efforts are made to make it better.

Insofar as the reports are correct, you have no shortage problem among bridge and building foremen, bridge and building iron workers, portable steam equipment operators and helpers, and pumping equipment operators. Your shortage problem, as shown by these data, is confined to bridge and building carpenters and painters, bridge and building helpers and apprentices, and bridge and building laborers.

I have not mentioned skilled water service workers. These are reported within the group, "masons, bricklayers, plasterers and plumbers." Although the number of current vacancies in this group is small, several railroads mentioned specifically that water service pipe fitter jobs were becoming increasingly difficult to fill.

Ninety-six per cent of the vacancies reported are in the four occupations that I have mentioned—bridge and building carpenters and painters, helpers and apprentices, and laborers. Your immediate concern, therefore, must be with these groups.

Most of your losses of employees result either from induction or enlistment in the military forces, or from transfer to other industries. It is usually true that transfers to other industries are by far the more important of these two. You can do something about both of these matters.

Possible Deferments

Among the advisory instructions which had been given to all local selective service boards is an occupational bulletin bearing the title "Transportation Service Activity." This bulletin lists essential occupations in transportation under each of its branches. The railroad list includes 116 occupations. In that list are bridge and building and water service foremen, bridge and building iron workers, bridge and building painters, pipe fitters, plumbers, time keepers, welders and operators of the heavier types of portable equipment used in bridge and building operations. If you have men in these occupations who might be placed in Class 1-A, except for their occupation, or whom you cannot let go because you are unable to replace them within a reasonable time, it is both your right and your duty to submit on Form 42-A all the data which the Selective Service System requires for the making of decisions as to occupational deferment.

You should take Form 42-A very seriously and fill it out as completely and fully as you can. Make it apply as much as possible to the individual for whom you are requesting deferment. Never make the mistake of having the form a kind of carbon copy of a 42-A for another man in the same occupation.

There is also another highly important consideration in connection with occupational deferment. To obtain deferment, it is not enough that an employee be a necessary man in an essential occupation in an essential activity. There must also be a shortage of available personnel in the essential occupation such that the employee in

question cannot be replaced within a reasonable time. No argument is more compelling with local selective service boards than a showing that you have turned yourself upside down in a serious attempt to recruit and train the men that are needed for replacements.

The problems created by transfers to other industries and the necessity of expanding your forces are far more difficult than those raised by selective service. In this regard, the importance of regularizing maintenance operations is extremely pertinent. The more you can regularize the fewer men you need, and the more attractive you can make their jobs, the simpler your problems will be. I have been told that maintenance operations are sometimes controlled by month to month budget-making, which makes it difficult to keep maintenance of way workers employed continuously. To the extent that this situation may exist in the bridge, building and water service departments, I hope you are using your influence against it.

You should give consideration to a greater amount of pooling of employment in maintenance operations. There should be similar pooling arrangements between maintenance-of-way and maintenance of equipment forces. This pooling could even be extended to include several railroads within a given area.

Recruiting Problems

In spite of all you can do in this respect, you will still have a problem of recruiting, and possibly a problem of training. I think you should first exhaust all possibilities of locating applicants through the Federal Employment services. In

the second place, you should try to fill your employee ranks with as many men with both wives and children as you possibly can. In the third place, if you have not already done so, you should throw overboard the maximum hiring age limits which have been traditional in the railroad industry in the past.

I should also like to say a word for increasing the employment of



Without the Necessary Skilled Forces, Essential Bridge Work Would Be Seriously Handicapped

negroes in bridge, building and water service work. The employment of negroes creates problems to be sure. However, many employers have been able to solve these problems and the railroad industry should be able to do as well.

Women Workers

The personnel survey now being made by the Association of American Railroads includes questions as to occupations in which women are employed. I have examined all of the returns that are in to date, and have yet to find that even one

woman is employed in bridge, building and water service work. During the last war there were very few. Some, however, were employed successfully as pumpers, and could be so employed again.

I grant that the manpower situation will have to become rather desperate in this country before women employees appear in any large numbers in your departments. At the same time, it would be well to canvass your jobs carefully to determine whether there are not some in which women could be suitably employed.

Must Work Together

The Office of Defense Transportation is urging all employers in the transportation industry to undertake planned personnel programs on a basis of careful inventories of their own personnel situations. Several railroads have already begun to make personnel inventories. Combined with estimates of future employee needs, such personnel inventories will go a long way in enabling you to plan wisely in meeting problems of personnel shortages.

Finally, we are interested in increasing the effectiveness of the existing staffs of transportation employees. An important means to this end exists in programs of labor-management co-operation which were begun on the railroads many years ago, and which ought to be extended to the entire industry today. Time and again it has been seen that when employees are given a systematic means through which to express their ideas about increasing efficiency and preventing waste, they not only contribute good suggestions, but they also take a greater and

more favorable interest in the company for which they work.

The Division of Transport Personnel hopes to be able to assist the railroad industry in meeting its manpower problems. We will have to work together if this job is to be done. And, working together, we will do our level best to insure that manpower shortages will not result in any "slow orders" to the railways or in the transportation industry as a whole.

DISCUSSION

Armstrong Chinn (Alton): During World War I, women workers were used on the track by some railroads, and while I did not use any, I have talked to others who did, and the consensus was that they were about 75 per cent as efficient as men. It was thought that if they had been dressed as men are dressed, the efficiency would have gone up to 85 or 90 per cent by comparison. I do not know of any in the bridge and building departments except the 28 pumpers you mentioned. As the result of your contacts with Great Britain, do you know to what extent women are being used in that country in the bridge and building departments? This might give us some idea of what we could eventually look forward to in this country.

Mr. Fitch: I cannot answer that. I will have to wait until Miss Sells, who is our representative in England, returns. I do know that as far as shop operations are concerned, many women are being used, but with respect to bridges and buildings, I have no information. I have seen a lot of the girls who work in the torpedo plant in Alexandria, Va., and the only dif-

ference I can see between their clothes and the men's is that occasionally they wear little ornaments that a man would not wear.

You mentioned the fact that women may be only 75 per cent as efficient as men. Do you not think that in view of the war situation, it would be well to accept 75 per cent efficiency, if that becomes necessary, and let the man who is 100 per cent efficient go to war rather than keep him at home when he is needed in the army?

Deferments

Mr. Chinn: You told us how to get exemption for men who are vitally essential. You said to file an application with the federal employment service for replacements for men who may be drafted from the railroads. In some instances this would be a difficult thing to do. To illustrate, suppose a railroad has 50 bridge and building foremen and it is excepted that some of them may be drafted. The road files an application with the federal employment service and some morning, if it is lucky, 10 or 15 foremen show up. What would it do with these men, while waiting for its regular foremen to be drafted? We do not know that a man is going to be drafted until he receives notification from his Board. As a rule, this gives us very little time to act, and I wonder what we might do about that phase of it.

Mr. Fitch: That depends on the size of the operation. If it is large enough, it will soon get to the point where when you have such shortages you will have to feed in whatever replacements you can. In other words, you can place a bona

fide order with a federal agency. If they send you a man, employ him. But if you cannot place an order, because of having no shortage in any given occupation, then you cannot use such a device. However, the Selective Service will be after your men and will no doubt eventually take them.

Mr. Chinn: They have already done so.

Mr. Fitch: You will soon be in a position where you can give a bona fide order, so if the Railroad Retirement board or the United States Employment Service sends you a man, you can employ him, if he is qualified, and your shortage problem is solved with respect to that one man.

Mr. Chinn: Perhaps I did not make myself clear. If our foremen are taken, according to our working arrangement with the brotherhoods, we will bulletin the job and the senior man bidding, capable of doing the work, will be awarded the job. This would mean that no new man sent to us by the employment service would go in as a foreman. Should our application, therefore, be for, say, carpenters, painters and helpers?

Mr. Fitch: It would have to be for carpenters and painters.

Mr. Chinn: If they take the foreman, the oldest carpenter or painter or helper bidding, capable of doing the work, will be awarded the foreman's job. In other words, we must then ask for men to replace the men who take the foremen's jobs, and not for men to go out as foremen.

Mr. Fitch: As long as you have fully qualified promotable men. If, however, you do not have fully qualified promotable men, you

should request deferment on the foremen. A year from now, if things go on like this, many of your men will, on the average, be less experienced than they now are. It is going to be more difficult to find a qualified foreman. But as long as you have men qualified as foremen down in the lower ranks, you should, of course, follow your regular promotion policies.

Mr. Chinn: In a way, that explains the thing you told us, that the records show there is no shortage of foremen, and that is why there is no shortage of foremen. The shortage would be in the junior men.

Mr. Fitch: And that happens throughout the railroad industry where you have seniority relationships.

Employment of Women

G. S. Crites (B. & O.): I can throw some light on the use of women in the last war. I had the Baltimore-Washington and contiguous territories for the Baltimore & Ohio. In Baltimore there was quite a reservoir of Slovakian women workers who had track-work experience in Europe. By approaching one of the Slovakian leaders, I managed to get together a gang of 20 or 30 women to do track work. They were used largely for policing the property and keeping it clean. These women were so efficient that the war industries and the car building and munitions plants, came around to get my help. They wore such clothes that you could not distinguish them from men.

In Washington, for policing purposes, we had some very distinguished women — a banker's

daughter, a congressman's wife and others of that class. They thought it was patriotic to come out and keep the railroad properly policed. They were very strict in their dress, and you could scarcely distinguish them from men. We also organized gangs of colored women workers and used them for tamping track or ballasting new track.

In studying the efficiency of gangs through a number of years, we have found that the efficiency of a gang depends upon the foreman. In this connection, I also tapped the house of correction, the Bridewell between Washington and Baltimore, and the Maryland penitentiary for help during the last war. We split the force obtained from the Bridewell into gangs of 12 and put them under our regular section foreman. The efficiency under an unwilling foreman who could not plan the work was much lower than 16-2/3 per cent, considering that 2/3 of 100 per cent was normal efficiency. Under a competent foreman, who could plan and program his work, often the efficiency of the convicts was 120 per cent. For this reason, when you say the efficiency of a man is only 75 per cent, it means nothing.

Need More Men

W. A. Huckstep (M.P.): Were the statistics you gave on the number of bridge and building employees—45,000—the number employed as of a certain date?

Mr. Fitch: That was the last figure I could get and represented employment as of July 15, 1942.

Mr. Huckstep: We are faced with

the need for increasing forces very considerably, because under the conservation program and the use of salvaged material, we are now having to tear down many old buildings, using the material salvaged for building structures elsewhere.

Mr. Fitch: That may be one reason the figures I gave you, as of September 15, showed 5,000 unfilled vacancies in bridge, building and water service.

Mr. Huckstep: We have many army camps, which call for increased passenger and freight facilities, and additional platforms. All the industries that are going up require additional facilities of one kind or another. We need additional men beyond the number we have been using to take care of these projects, and if we are to carry out this conservation program adequately, it means additional labor. Increased heavy traffic on bridges means closer maintenance than would probably be necessary under normal conditions. So that the 45,000 mentioned might be 20 per cent under what would be the actual need today.

Mr. Fitch: The figures I gave you as of September 15 would indicate that bridge and building forces would be 45,000 to 50,000 today, if the railroads could get the men.

Discourage Retirements

A. L. McCloy (P.M.): I have a few men who are almost to the age of 65, when they will be subject to retirement. Is it good policy for us to try to discourage their taking this retirement?

Mr. Fitch: I would say yes, by all means. If these men are still phys-

ically able to carry on with any reasonable degree of efficiency, even though it may not be 100 per cent, I would do everything I could to discourage them from retirement until after the war.

Mr. McCloy: Well, they registered under Selective Service in the age group from 45 to 65. Are they still subject to that now for the duration, or do they go out from under it at 65? That is one thing I would like to be able to tell them.

Mr. Fitch: The registration of the 45 to 65-year-olds has not meant anything as yet. I think they will continue to be regarded only as registrants.

Mr. McCloy: If they retire from the railroads, are they subject to call into some other industry?

Mr. Fitch: I have not said much about the War Manpower Commission. Mr. Beyer, director of my division of ODT, is a member of that commission representing transportation. If the manpower commission gets to the point where it is enforcing policies of transfer from one industry to another, and not merely on the basis of persuasion, then there might be some chance these older men would be affected. I think that possibility is somewhat remote at present. If these men decide to stick to their railroad jobs, no one will try to shift them to other activities when their experience and training are in the railroad industry.

Mr. McCloy: The point I am bringing up is, if they are retired and doing nothing, then would they be subject to being called to some other job?

Mr. Fitch: That might happen, not now, but at some future time.

President Dove: That is the argument you would want used in influencing them to remain in their railroad employment.

Mr. McCloy: Yes, that they would be subject to call to work in a factory or some place else, if they quit the railroads.

Mr. Crites: Of course, there is one disadvantage to that argument. They can retire legally as railroad employees and draw their pension, and then be employed by an outside industry.

Mr. Fitch: That is the trouble. If retired railroad workers go back to the railroad industry, they lose their pension during the period of their employment. If they go back to work for some employer other than a railroad, they keep both their wages and their pension.

Mr. Huckstep: Has the re-employment of retired men reached the saturation point for most existing gangs? In almost every gang I have noticed, there are as many older men in the gang as can be used. There is a limited amount of work which older men can do. They cannot work from a scaffold; they cannot work out on a trestle.

But there are other parts of the work to be done which they can do, and most gangs I have observed have just about as many of these partially impaired men as they can use to advantage. Now, if we take a lot more of these older men and men who have retired, just what are we going to be able to accomplish?

Mr. Crites: This year, we took young men from high schools and others between 18 and 20 years into our gangs, and we used the older men to direct and point out to these younger men how to put up their scaffolds and proceed with their work. They were sometimes rather timid at the start. We have augmented the force and utilized the older men in this way, and we have kept some of the men past 65 by this plan. Now, we will probably be confronted with the necessity of taking boys under 18, and they will have to be selected very carefully.

President Dove: Mr. Fitch, we are certainly indebted to you for this fine address, while we know we still have a problem, we have a better understanding of how to meet it. Allow me to express the thanks of the association and of everyone in this room.

Conserving Bridge and Building and Water Service Materials

Report of Committee

Committee—F. G. CAMPBELL (chairman), asst. ch. engr., E. J. & E., Joliet, Ill.; M. D. CAROTHERS (vice-chairman), div. engr., Alton, Bloomington, Ill.; W. L. ANDERSON, off. engr., C. & N. W., Chicago; M. L. BARDILL, asst. engr., C. M. St. P. & P., Savannah, Ill.; W. A. BEGEMAN, for. b. & b., M. P., Jefferson City, Mo.; H. F. BIRD, asst. supv., b. & b., N. Y. C., Syracuse, N.Y.; S. T. COREY, asst. br. engr., C. R. I. & P., Chicago; H. G. JOHNSON, instman., C. M. St. P. & P., Ottumwa, Ia.; A. C. JONES, supv., b. & b., Sou., Parish, Ala.; C. R. KNOWLES, supt., w. s., retired, I. C., Chicago; L. R. PENNINGTON, supv., b. & b., C. & N. W., Chadron, Neb.; L. E. POHN, asst. engr., C. M. St. P. & P., Miles City, Mont.; F. A. SCITES, supv., b. & b., & w. s., C. & O., Huntington, W. Va.; C. W. STEPHENS, asst. engr., struc., D. & H., Albany, N.Y.; and G. L. SUMMERS, w. s. reprman., M. P., Bismarck, Mo.



F. G. Campbell
Chairman

The conservation of materials is not new to bridge and building men, having been followed since the first railroad was built. While it has always been important, it probably was never as important as at the present time. Heretofore

it has generally been a matter of primary concern to the railroads alone, but now it affects the welfare of the entire nation.

The reasons for the conservation of materials are varied and the importance of these reasons has also varied at different times. One reason which we have always had with us is that of economy. It always has been—and of course always will be—good practice to make use of secondhand materials and equipment where such use in the long run is more economical than the purchase of new materials and equip-

ment. Often, however, the use of secondhand materials is brought about through the inability to purchase like new materials. During the depression this was prevalent because the low earning power of most railroads made funds unavailable to buy new equipment and materials, even when it was economical to do so. We are again faced with inability to obtain many of the things which we need or could use economically, not generally because of lack of funds but because of the great need of these same materials by our armed forces, and we are again faced with the necessity, regardless of the economics thereof, for substituting old for new, which is merely another way of saying "conservation of materials." This goes even further than the mere inability to obtain new materials since it is now our patriotic duty to avoid, in so far as possible, the use of any of the critical materials needed in national defense, or offense, even when we can secure them. Therefore, our first thought must not be, "Can I secure the new materials and equipment which I need" but, rather, "Have I anything old which I can use?" and thus avoid or postpone even the endeavor to secure new materials and equipment. Because of present conditions, it is the purpose of this report to go the limit in conservation of ma-

terials, regardless of the economies thereof.

One important phase of the conservation of materials is the securing of the maximum life of materials in initial service. This is generally good maintenance practice at any time, since it will usually result in economies. At this time more frequent and probably more careful inspections should be made of our present structures. Steel structures should be cleaned and painted with sufficient frequency to reduce to a minimum loss through rust or other corrosive action. Wood structures should be kept tightened to avoid mechanical wear and, wherever necessary, should be painted to retard decay. All materials in service should be kept as free as possible from moisture and dirt. Minor repairs to composite structures, such as roofs, should be made whenever opportunity arises. This may not always be economical but will conserve materials since it will postpone the time when renewals of entire facilities must be made.

Use of Welding

The welding torch has proved to be of marked aid in the prolongation of the service life of steel structures. When girders are reduced through corrosion near the end bearing plates to the extent that they need repairs, the wasted steel can be restored to its original strength by welding plates on the angles and webs. These plates can often be secured from our stores of secondhand materials.

Some of our older steel structures were designed for lighter loads than they are now required to carry. Many of these structures can be strengthened by welding to them additional stiffener angles or other additional support, thereby keeping in service for

a number of years structures which would otherwise have to be replaced through a large expenditure of steel for a new structure.

Greater Use of Secondhand Materials and Equipment

Whenever it is necessary to build a new facility, to acquire new equipment, or to make extensive repairs to existing facilities and equipments, a careful check and inspection should be made of all secondhand materials on hand which may possibly be of use, before ordering any new materials. The general scrap dock often proves to be a source of such materials. Often materials which cannot be used by another department, can be used to advantage by the bridge and building department. This is true especially of materials scrapped by the car department through the dismantling of cars. As a minor example, reasonably good rail clips can be made from car scrap. Car rods can be threaded and made into bolts. Scrap steel plates from gondola and hopper cars make excellent bridge floors and can also be used extensively for the protection of ties from ash pan dumpings in the vicinity of coal and water stations. Planks from the sides of wood side gondola cars can be used extensively in platforms, temporary crossings, scaffolding, and for many other purposes. Car steel can be cut into satisfactory reinforcing rods.

Cinder Pit Expedient

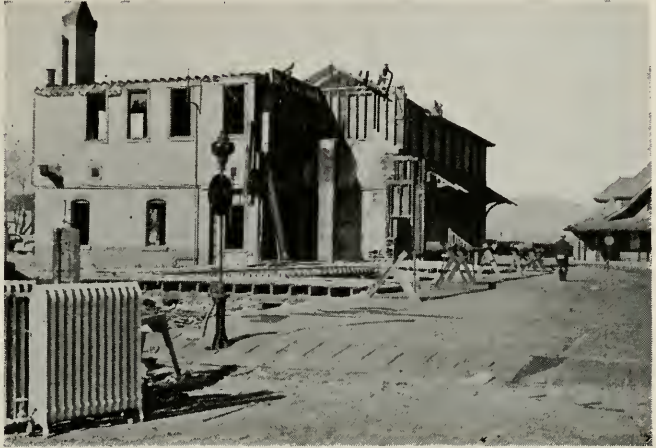
A common type of construction for cinder pits is a heavy plate bearing upon the concrete wall to carry the running rail. Because of rapid deterioration, these plates have to be renewed frequently. Plate steel is now almost impossible to obtain. A very satisfactory substitute is the con-

creting of short pieces of scrap rail, base up, in the top of the wall. The running rail can then be clipped to these transverse rails.

Equipment can, when necessary, usually be continued in service almost indefinitely through repairs. True, this may not be economical, but under

timber. We know of a recent case where a steel trestle had, through deterioration, become so weakened that it was approaching an unsafe condition. Under ordinary conditions, this trestle should have been completely renewed in kind but this would have required a large amount of new

Before Any Structure Is Dismantled, Study Should Be Made to Determine the Best Method of Removing the Materials with the Least Possible Damage



present conditions it must be done to the limit of our ability. Also new repair parts are now often difficult and sometimes impossible to obtain. Diligent search, however, will sometimes disclose that parts from discarded machines, possibly of an entirely different type, may be used. Often obsolete or worn-out machines, or major parts thereof, may be converted to other uses. For example, chassis of track-mounted air compressors and concrete mixers can be made into very acceptable heavy push cars. Cables, on cranes and hoists, which have become inadequate in their original location can be passed along to lesser requirements, thus considerably reducing the necessity for new cable.

Probably one of the most fertile fields in the conservation of materials, but also probably the one given the least thought, is the use of secondhand

steel. Temporary repairs were made by placing wooden helper bents along each side of the old steel bents. These wooden bents were made entirely of secondhand timber, most of which was recovered from a dismantled wooden coal chute and from the sound portions of stringers recovered from the renewal of a timber trestle. The job is not sightly and it was probably uneconomical; however, it will last for several years and the use of a large amount of new steel has been postponed for the duration of the war.

Use Second-Hand Ties

A source of much valuable second-hand timber for the bridge and building man is the creosoted track ties discarded by the track department. Such ties are often removed from the track on account of splitting or spike cutting and contain no decay. Even when

such ties are removed on account of decay, the decay is usually localized and the majority of the tie is still sound. These ties make excellent cribbing and retaining walls. Sound portions of such ties can also be used in the building of catch basins. In such use they will not, of course, last forever, but we believe that in these uses, where no mechanical wear is encountered, the length of their service life will be considerable.

The substitution, through change in design, of less critical new materials for those highly critical is probably not within the scope of this committee. It is, however, of such vital importance at the present time that we feel it should at least be mentioned in passing. Steel is probably the material most needed in the greatest volume by our armed forces. The designer of new structures can greatly reduce the consumption of steel by the substitution of other materials, especially creosoted timber and concrete. The art of preservation of timber has now advanced to the point where its use in place of steel should be given careful consideration. While reinforced concrete does, of course, require some steel, its more extended use will greatly reduce our requirements for steel plates and shapes.

Salvage and Rehabilitation

In addition to the added thought which we must now give to the use of secondhand materials, we must give equal thought to the procuring of such materials. This leads us to a study of the proper methods of salvaging and rehabilitating used materials. Before any structure is dismantled, the building superintendent or engineer in charge should make a careful inspection to determine the best method of removing the materials with the least possible damage. This will probably

require a great deal more labor than was used on similar projects in the past. He should probably plan to leave his cutting torch in the shop. During the past few years we have undoubtedly saved a great deal of money through the use of this very efficient tool; however, in making this saving, we have reduced to scrap a great deal of steel which could have otherwise been used. Now our major problem is not the saving of money but the saving of vital materials. Let us then, for the emergency, lay aside the cutting torch in so far as it is an instrument of destruction. In recovering steel members, it has been customary in the past to burn them off near the end supports, which facilitates removal but destroys the connecting members. If, however, we are to go the limit in our conservation program, this practice must be discontinued and all members, even including bolts and nuts, must be carefully removed and saved. Salvaged steel should be cleaned and painted as quickly as possible, and if not re-used immediately, should be carefully classified and stored.

In the recovery of flanged pipes, the flanges, bolts and gaskets should be removed carefully. They should be cleaned immediately and, if it is probable that they will be stored for some time, they should be given a coat of preservative oil or paint. In recovering pipe with screwed couplings, it is often found that the couplings cannot be broken loose. In such cases the pipe should be cut off as close to the coupling as possible and rethreaded, thus preserving almost the entire original length of the pipe.

In the salvaging of lumber and other materials, care should be taken to reduce breakage to a minimum. All nails and bolts should be removed as soon as possible. If the timber recovered has been treated with creosote

or other preservative, all bolt and spike holes—especially those which do not extend through the entire timber—should be plugged with creosoted plugs. All split and decayed sections of recovered timber should be removed immediately. Dirt and other foreign matter should, in so far as possible, be removed immediately from the recovered timber.

Often considerable work of rehabilitation must be done on the recovered

either from stock or purchase. Also, if such salvaged material is allowed to remain as recovered for a considerable length of time, the use for which it is intended may be lost sight of and it is likely to be kicked around and eventually reach the scrap pile instead of being used to better purpose.

Of equal importance with the salvaging and rehabilitation of materials is their care after those processes have taken place. Foremen and others in

**"Steel Structures
Should Be Cleaned
and Painted With
Sufficient Frequency
to Reduce to a
Minimum Loss
Through Rust or
Other Corrosive
Action"**



materials before they can be reused. The processes which must be used are too numerous for detailed consideration, but are usually obvious. Often bolts which have been recovered have damaged threads. These must be re-threaded and in some cases the damaged threads must be removed, with the result that the reclaimed bolts are somewhat shorter than the original ones. Spikes, bolts and drift pins will often have to be straightened. Recovered valves are often in need of repair before they can be returned to further use. It is important that this rehabilitation work be done as quickly as possible after the materials are salvaged. This will make the materials available for emergency use and thus avoid the use of new materials,

charge of materials should be taught, especially at this time, to give equal thought and effort to the care of usable material as they do to the care of new material. Usable lumber, where possible—especially if untreated—should be stored under cover. If it is necessary to store it outside, provision for the circulation of air should be the same as in the storing of new lumber. Usable steel, after having been cleaned and painted, should be placed on blocking above the ground and care should be taken so that it does not come in contact with cinders, dirt or other foreign matter. Small hardware should be stored and classified in bins in the same manner as is usually followed with new hardware. A complete inventory of all usable material

should, so far as possible, be available at all times, since this is a necessary aid to the most extensive use of usable material in the planning of work.

DISCUSSION

President Dove: One thing that struck me during the reading of this report was the statement that, "Often obsolete or worn-out machines, or major parts thereof, may be converted to other uses." In talking with one of the officers of our purchasing department last week, he stressed the use of obsolete material. It was his belief that many outmoded items still remain in stocks, and he believes that those materials can be used to advantage in many places, thus eliminating the necessity of purchasing new materials. Actually, the use of obsolete material increases the stock of material available.

Armstrong Chinn (Alton): To me, the most important thought in the report is that during these times we must pay special attention to salvaging usable materials, because materials of most kinds are now scarce. As a matter of economy, it is always proper to salvage re-usable materials where such salvage produces a saving, but now we have to salvage these materials, not so much because of the saving effected, but because the materials are scarce and hard to obtain, and in some cases unobtainable. So, as Mr. Campbell has pointed out, we must forget the monetary economy and look at it from the standpoint of the economy of the material itself. In the past, we have always thought of how much we were saving in dollars and cents, whereas, we must now forget that and deter-

mine how much we are saving in actual units of material.

Some years ago, we abandoned one of our branch lines because it was not profitable and we left the cast iron culverts in place because it would cost more in labor to salvage them than they were worth. Now we are back there salvaging those cast iron culverts.

L. D. Garis (C. & N. W.): When I first started bridge inspection 17 years ago, I got the idea that I was a secret service agent to see to it that the divisions lived up to the standard plans. One of the things that has always bothered me is how much liberty a man in the field should have in disregarding standard plans and using his ingenuity.

President Dove: We are going to find that conditions now prevailing are going to make the old adage, "necessity is the mother of invention," more pertinent than it has in the past.

Must Give Up Standards

Mr. Chinn: It is well to have standard plans and to adhere to them when we have the material and the money, but when we cannot obtain materials, which is the situation in which we now find ourselves, we are going to have to keep the structures safe, regardless of standards.

W. A. Huckstep (M. P.): Has the committee received any information or suggestions as to what can be substituted for gutters and downspouts on buildings, aside from building wood troughs.

Chairman Campbell: Many buildings have unnecessary gutters and downspouts. In many instances they could be eliminated.

Mr. Huckstep: The trouble has been that during the lean years the old gutters and downspouts were left in place and have deteriorated so that they are not usable.

President Dove: The roads are turning more and more to buildings that are not actually in operation for the recovery of usable material, especially in the way of plumbing supplies.

R. E. Caudle (M. P.): In the past few months our lines have discarded standards for our branch line construction. We will continue to use our present standards on the main lines as long as we have the materials available. When we no longer have the materials available for building a standard structure or repairing one, we will use something else. For a number of years we have kept our branch lines up with material salvaged and removed from the main line. Formerly, we used untreated fir stringers in our open-deck trestles on both the main and branch lines. When an untreated fir stringer decays, it is always over the cap at the center of the 28-ft. stringers and at the ends. That is the cause for the removal of a large number of stringers, yet a large portion of the stringer will be perfectly sound. We are now using the length between the bearings, which is sound timber, and are cutting that into branch-line trestle ties because we are getting

short on that class of new material.

Where we do not have a timber long enough to make a 9-ft. trestle tie, we cut it into a 4 or 5-ft. block and send it to the treating plant for treatment, for use as a footing block under a frame bent.

At division points, we have a maintenance man and a reclamation man inspect material from structures as it is unloaded from cars. They divide it between scrap and serviceable material or material to be made serviceable. It then goes through the reclamation plant and is put into condition. The supervisors watch closely and send the hardware and other material out mainly to the branch lines for re-use. It is going to be necessary to save everything from renewed or repaired trestles; this material may be of some benefit before we get over the present shortage.

G. S. Crites (B. & O.): In patching steel bridges by welding, a competent designer should prepare plans showing where and how the reinforcement is to be placed and this should not be left to the ingenuity of some welder. If we cannot supply the designer in the bridge department with exactly the second-hand materials that are required, the ingenuity of both the designer and the man in the field will be called upon, but it should not be permitted to run wild or be used on structures without first obtaining proper plans.

Meeting the Demands for Increased Water Supplies in Fast Freight Service

Report of Committee

Committee—J. P. HANLEY (*chairman*), w. s. insp., I. C., Chicago; R. E. CAUDLE (*vice-chairman*), asst. engr. strs., M. P., Houston, Tex.; A. E. BECHTELHEIMER, br. engr., C. & N. W., Chicago; W. D. BIRD, gen. for., b. & b., A. T. S. F., Albuquerque, N. M.; L. A. COWSERT, w. insp., B. & O., Dayton, Ohio; H. C. CRAWFORD, gen. for., b. & b., S. P., Dunsmuir, Cal.; V. E. ENGMAN, ch. carp., C. M. St. P. & P., Savanna, Ill.; W. A. HUTCHESON, supv. b. & b., C. & O., Clifton Forge, Va.; F. M. LEHRMAN, br. dftsman., C. & N. W., Chicago; C. A. J. RICHARDS, mast. carp., Penna., Grand Rapids, Mich.; H. T. RIGHTS, br. engr., retired, L. V. Bethlehem, Pa.; D. C. SHADDOCK, for. w. s., N. Y. C., Corning, N. Y.; J. L. VARKER, supv., b. & b., D. & H., Carbondale, Pa.; M. P. WALDEN, asst. supv., b. & b., L. & N., Evansville, Ind.; and K. J. WEIR, special water service inspector, C. M. St. P. & P., Chicago.



J. P. Hanley
Chairman

the pride of each division superintendent and cars were held back until full tonnage could be assembled before starting trains from initial terminals. This does not mean that tonnage is now neglected, but rather that certain freight trains have been placed on timetable schedules like passenger trains and on such trains tonnage is limited by the running time and speed which are definitely maintained. In a recent article in the public press, J. J. Pelley, President

One of the outstanding trends in railway operation has been the increasingly fast schedules of freight trains during the last three or four years. Gone are the days when the heavy slow moving "drag" was considered the

of the Association of American Railroads, stated that the railways moved 470 billion gross ton-miles of freight in 1941, or 5.1 per cent more than in the previous high year of 1929. Last year the railways hauled more freight per train than ever before and moved each train over the road nearly one and one-half times as fast as 20 years ago. Freight car capacity averaged 50.4 tons, or 18.6 per cent more than in 1921. Tractive effort of locomotives averaged 51,495 lb., or 39.4 per cent more than in 1921.

In order to maintain the schedules necessary to accomplish the results mentioned, certain changes have been made in servicing the locomotives handling these trains, such as servicing them at division points without detaching them from trains, which practice, in turn, requires quick watering, coaling, fire cleaning and other train service work.

Previous Reports Valuable

This report will consider the water facilities required, and should be considered in connection with two previous reports submitted to the association. In 1937 a committee, of which

Mr. H. B. Christiansen was chairman, presented a report on Meeting Today's Demands for Water Service, and in 1940 a committee under the chairmanship of Mr. W. G. Powrie, presented a report on The Adjustment of Locomotive Watering Facilities to Larger Tenders and Higher Speed Trains. The Water Service committee of the A.R.E.A. also presented a valuable report to that association in March, 1941, on The Practicable Size of Water Columns and Supply Lines for Maximum Delivery of Water to Locomotive Tenders. This latter report points out that the adequate delivery of water generally depends on: (a) The size, length and condition of the supply pipe; (b) the flow head above the water column outlet; and (c) the size and design of water column. All of these reports present useful information and should be studied carefully by members of this association preparatory to attacking a condition that has now become very urgent on many railroads of the country.

The fast freight locomotive now requires a larger volume of water at increased flow rates at locations often designed for much less severe operating conditions. The practice has resulted in placing unusual demands on terminal and key stations and decreasing demands at other points. In order to show the methods used, the committee presents a summary of the replies received from a few roads representative of different parts of the country and showing somewhat different methods of handling the water supply problems.

Railway "A"

About the same time that freight trains were speeded up, fast passenger runs were also inaugurated, and although this report refers to freight service, the increased demand for

water for passenger trains also enters into the picture. In many cases the improvement of water stations was made principally for the passenger service, but also benefits freight trains.

As freight and passenger schedules were speeded up, one of the features contributing to maintaining the schedules was the reduced time consumed in taking water and coal and servicing the locomotives en route. It was found that many minutes could be saved if water would be delivered into the tenders faster, or coal and water could be taken at one stop, which would also include inspection and ashpan work. As studies were made, it was found that in a few instances improvement could be made at a small cost, but that in most cases it was necessary to spend considerable money to make the desired improvements.

When the railways were constructed originally, water stations were located where water was obtained most easily, regardless of the quality of the water or the grade and alinement of the tracks. At that time information on underground water sources was not available. It is now the policy of this railway, as water facilities require renewal or become inadequate, to relocate them at the proper places from an operating standpoint. Wells are drilled if necessary, where underground water is satisfactory. Where underground water is not available or not suitable for boiler use, storage reservoirs are provided to impound surface water or water is taken from a stream that has a dependable flow. By this procedure, the number of active water stations has been reduced.

While we do not need intermediate water stations for fast trains, we have local service, industry switching, in-

terchange points, junction points and work-train service for which these stations are necessary. Furthermore, the main water stations are shut down at times for repairs and the intermediate stations are then used. The conditions, however, have forced the concentration of maintenance on the main stations with good results.

It has been the practice on this rail-

stallation delivers 5,000 gal. per min. and has demonstrated that a large flow can be taken from a water column without hazard to the man taking water. Where water is taken direct from a tank through a sway-spout, the present type of valve and spout limits the delivery to about 3,000 gal. per min. Perhaps a valve and spout can be designed to secure



Larger Engine Tenders and Auxiliary Water Tanks Have Eliminated the Need for Stops at Many Intermediate Water Stations

way to use electric power for operating pumping plants wherever dependable current is available. For surface supply, centrifugal pumps are used, while for deep wells, turbine pumps are used.

To increase the flow of water to locomotives where fast trains are watered, improvements have been made at some places by eliminating bottle necks in pipe lines, such as installing wyes in place of tees, eliminating restricted places in pipes and cleaning pipes where the size is reduced by incrustation, and in some cases by installing a larger water column. At some points it has been necessary to raise the storage tank, install a larger tank or increase the size of the pipe serving the water column.

Improvements of this kind usually secure a flow into the tender of 4,500 to 5,000 gal. per minute. One in-

a better flow for sway-spout installations.

With the faster freight service, a greater demand for water has been created at the main and halfway points. This has necessitated larger storage tanks, larger pump equipment, and, in a few cases, increased sources of supply. Correspondingly, the demand at the intermediate points has decreased.

At several points on this railway, water columns and cinder pits have been located so that the ash pan is cleaned and coal and water taken with one stop. This is a desirable arrangement at all main points where fast freight engines are serviced, but in some cases this is not feasible on account of the track layout, or where the expense cannot be justified.

In planning future water station improvements, it is well to take a long-range view and study the effect that

Diesel locomotives will have on water demands.

The faster train service and increased demand have placed a greater responsibility on the water service department. Materials are not now available for desired improvements, and this may also affect materials for repairs to existing facilities. These conditions provide a test of the ingenuity and resourcefulness of the water service forces in maintaining the water supply facilities in first-class shape.

Railway "B"

The territory on this road referred to in the following is a double-track main line on a route of heavy trans-continental fruit and meat traffic, as well as general freight traffic. The distance between terminals is 124 miles. There are three scheduled time-freights westward and seven eastward each day, and the fastest scheduled time between these terminals is four hours for eastward trains and four hours and twenty-five minutes for the westward run. There are also, of course, such extra trains as the traffic requires. The fleeting of trains has been the practice for many years.

The locomotives hauling these trains have 275-lb. steam pressure, and are equipped with stokers, feedwater heaters and boosters. Their tractive power is 71,400 lb. Tender capacity is 18,000 gal. of water and 25 tons of coal. Three water stations have been closed since these large locomotives were placed in operation.

No attempt has been made to arrange water and fuel supplies to provide one-stop service. It is thought that falling coal might interfere with handling the water spout and that coal particles might get into the water. The plan is to deliver 3,000 to 4,000 gal. per min. at water stations, which

fills the large tenders in four to five minutes and is satisfactory without attempting to secure the additional saving in time that might be made by combining facilities.

In 1928, when one of the large terminals on the road was completed, a reservoir was built for the purpose of storing and reclaiming surface drainage and waste water from the engine-house and auxiliary facilities to supplement the supply of water then obtained from deep wells. In 1936, a pipe line was installed along the right-of-way to carry city water to the terminal. This pipe line discharges into the reservoir above mentioned. Water is drawn from the reservoir through a treating plant and thence to pipe lines and water columns by centrifugal pumps. This terminal has a peak hourly demand of 250,000 gal.

At the opposite end of the division the source of supply is a large river where the water is treated in a plant on the river bank and transferred to the shops and enginehouse by centrifugal pumps. At other water stations the source is underground, as there are no satisfactory surface supplies.

Railway "C" Oil Burning Locomotives

Seventy per cent of the company-produced locomotive water is pumped from deep wells on this railway. Many of the wells and deep well pumps, with their 50,000 to 75,000-gal. capacity roadside tanks, do not furnish enough water to meet the peak demand of a fleet of 4 to 8 trains requiring water within a period of 2 to 4 hours. The peak demand has been met at several stations by installing surface pools of from 50,000 to 100,000 gal. capacity, and installing horizontal pumps of large capacity to elevate the water from these reservoirs into tanks. At these

points, the deep well pumps discharge into the tank until it is filled, and then pump into the surface reservoir, thereby storing water to be elevated into the tank by the larger capacity horizontal pump as soon as the water in the tank is lowered to the required point. These installations are operated by automatic control.

Where steel tanks are available, the capacity has been increased sufficiently to meet the demands of fleets of trains by riveting or welding rings to their tops. Where wood tanks exist and it is not satisfactory to install surface reservoirs, an additional tank is installed.

Standby connections are often installed with municipal and private water works. The connections are provided with float valves so the water will flow when the water in the tank is lowered to some fixed point, thereby augmenting the delivery into the tank in time of heavy demand during short periods of time. Where it is not too expensive, another well and pump are installed to serve the purpose of a standby and are automatically controlled to cut in and increase the delivery when fleets of trains lower the water in the tank.

Number of Stations Reduced

This railway has 106 water stations on 3,000 miles of line; 38 of these stations have water treating equipment in operation. Ten years ago there were 140 water stations. The stations are operated by 12 regular and 20 part-time pumpers. Larger tenders and auxiliary tanks on locomotives, plus automatic operation of plants, permitted the reduction in the number of stations.

Larger engine tenders and auxiliary tanks attached thereto have made a saving in the water service department alone of \$25,000 annually, main-

ly by eliminating intermediate water stations. Large engine tenders and auxiliary tanks made a much greater saving in money, as well as in time by reducing the number of train stops for water. A 24 per cent reduction in the number of water stations means a corresponding reduction in the number of train stops for water. Therefore, the saving in train operating costs, considering time that was lost, added wear on equipment and extra fuel, and miscellaneous items, amount to a considerable sum annually.

Since the attack on Pearl Harbor it has become the duty of the American railways to render the greatest possible service to our country in defending its borders against armed aggression. The railways were generally in an excellent state of preparation to undertake the efficient handling of the greatly increased tonnage. Power and equipment had been conditioned for service, and locomotive water and fuel facilities were in good condition to meet the demand.

Demand May Continue

It is probable that the demand will continue to increase for the next few years. After the war, any decrease in the transportation of war materials may be off-set by the peace-time requirements. It is reasonable to assume that it will be the problem of the United States to furnish food supplies for the peoples of a large portion of the world whose stocks will have been exhausted during the conflict; also to furnish essential materials and machinery for their economic rehabilitation. Therefore, the railway water service personnel should have plans to meet this increased water demand.

While this railway does not have a continuous density of traffic and a large number of trains, it is subjected to "fleets" or multiple sections of

trains operating from a half hour to an hour apart, which results in heavy withdrawals from water tanks in short periods. In the Southwest, it is the opinion that demands on the railroads are going to increase considerably in the next few years, and arrangements are being made to meet these increased demands by installing temporary water stations at "third points" where water is now being taken at "half

to a location near the column or install a second tank near the column

(4)—The installation of large-capacity booster pumps in the supply line between the tank and the column is not recommended. In the event of failure of the pump, the flow of water is obstructed.

Railway "D"

The largest tenders on this railway have a capacity of 15,000 gal. of wa-

This Large Freight Locomotive Takes Water on the Main Line in Four to Five Minutes



way" points and at "quarter points" on districts where large engine tenders are used. Temporary stations are also being installed convenient to yards where considerable switching is done to serve the larger industries and army camps. Each individual water station should be watched closely and prompt measures taken to augment the supply if a shortage of water is indicated. The following methods are suggested for improving the water flow to tenders where necessary:

(1)—Raise the tanks that supply the water column

(2)—Lay an additional pipe line from the tank to the column or install a larger column

(3)—In the event that the tank is located too far from the column, move the tank

ter, and fast freight trains often operate from one terminal to the next without a water stop. Auxiliary tenders are also used. These tenders contain 12,000 gal. of water and are coupled behind the regular tenders of 11,000 gal. capacity. This combination then has a total capacity of 23,000 gal. Such combinations also enable fast freight trains to operate over an engine district without a water stop.

The use of the auxiliary tenders was developed because the locomotives were originally secured with 10,000-, 11,000- and 12,000-gal. capacity tenders, which were inadequate for non-stop use. When the large single tenders and combinations are used on semi-fast freight trains, these trains

make one intermediate stop for water between terminals. The manholes in the auxiliary tenders are spaced so that it is possible to fill both tenders with one "spotting" of the locomotive. Efforts are being made where new coaling stations are erected, to space the coal filling and water filling equipment such that both coal and water can be delivered without respotting the engine. This condition is also planned where cinder pit facilities exist for servicing the engine on the main line without detaching it from the train.

The use of large-capacity tenders has placed an unusually heavy demand on the terminal and key stations and has permitted the retirement of many of the intermediate stations. However, all freight trains cannot go as far for water as the manifest runs, so it is necessary to maintain many intermediate stations for a small demand. The heavy tonnage trains and the local freight trains still require rather close spacing of water stations.

This railway is using automatic electric pumps at many stations where steam equipment was formerly used, and has recently installed an automatically-controlled Diesel engine for pumping water. This engine is started by means of the usual electric starting motor, which, in turn, is actuated by a float switch on the tank. The engine is equipped with a generator and a dual set of batteries to supply the starting current, as commercial current is not available.

Numerous complaints have been received relative to the length of flow time required to fill the large tenders through existing water columns and water column mains, and this condition will probably warrant the use of 14 or 16-in. diameter mains in future installations, instead of the present 12-in. mains, depending on their distance from the tank. It is believed that

larger mains are preferred to higher tank towers, and that 12-in. water columns are large enough when supplied by mains of adequate size.

Other Information

Information submitted by committee members showing conditions on their respective railways has been summarized as follows:

The maximum number of locomotives taking water at the heaviest water stations is 20 to 94.

The water capacity of locomotive tenders is 9,000 to 22,500 gal., and the capacity of auxiliary tenders, where used, is 12,000 gal.

The coal capacity of tenders is 20 to 26 tons, and the oil capacity, where this fuel is used, is 11,660 gal.

The means usually taken to improve water column flow is: (a) clean pipe and eliminate restricted sections; (b) raise water tanks; (c) install larger supply pipes; (d) install additional supply pipe and connect them to the existing main.

One railway using oil as fuel reports the use of 11,660 gal. of oil as compared with 161,000 gal. of water per 1,000 locomotive miles, or a ratio of 1 gal. of fuel to 13.8 gal. of water used.

The time required to fill the larger tenders is 5 to 12 min.

Fast freight trains usually go 80 to 125 miles between stops for water, from 80 to 160 miles for coal, and 250 miles for oil.

The use of large tenders has generally lightened water station maintenance by concentrating the work on key stations and permitting the closing or reducing the maintenance on intermediate stations.

The "one stop" principle is generally preferred for taking fuel and water where facilities can be arranged without excessive cost.

The use of larger tenders has indicated that increased roadside storage, surface reservoirs or increased flow into existing storage, are often, but not always required.

The unit coal consumption in fast freight service is 70.5 lb. per 1,000 gross ton-miles, and 265 lb. per engine mile, while the unit water consumption in such service is 55 gal. per 1,000 gross ton-miles, and 160 to 205 gal. per engine mile.

Conclusions

(1) The use of locomotive tenders with a capacity of 20,000 to 25,000 gal. is pronounced at the present time and it appears that this practice will be extended.

(2) The water flow and capacity to supply larger tenders promptly are inadequate at some stations, and plans should be made to correct existing conditions and to prevent their recurrence in future installations.

(3) A flow of 4,000 to 5,000 gal. per min. should be provided in new or remodeled installations, and pipe sizes and flow head for this condition installed.

(4) In new construction, the use of 14-in. and 16-in. water column mains should be considered instead of the 10-in. and 12-in. sizes formerly used. However, the flow head tables, after deducting friction losses, will indicate the correct size for 4,000 to 5,000 gal. per min. as now required.

(5) The use of increased roadside storage at key and terminal stations, or increased inlet flow into existing storage, is often required to supply large tenders during peak periods. The increase in storage may sometimes be secured by relocating tanks retired at intermediate stations.

(6) The demand at intermediate stations has increased but these

stations cannot always be eliminated as they are required for local trains, switchers, junctions and industrial tracks.

(7) The use of surface reservoirs near roadside tanks and connected to them with a large capacity booster pump may be suitable in some locations to replenish quickly the water taken from the roadside tank by "fleet-ed" trains.

(8) The use of an additional pipe line to increase the supply to water columns is generally preferred to installing a much larger single main to secure the capacity and then salvaging the older main. This method is sometimes referred to as a "loop" system.

DISCUSSION

President Dove: When this subject was selected it was appreciated that there had been two reports on similar subjects only a few years ago. However, the Subjects committee believed that there was more information to be developed. This is confirmed in the present report. There is a tendency to go to larger capacity tenders, and to larger supply lines. The installation of larger lines may be restricted because of the materials situation. In this connection, is there a tendency toward the use of electric motors instead of Diesel engines to conserve fuel oil?

Chairman Hanley: The use of both types of equipment is restricted. If an electric power line needs to be extended more than 500 ft., it is necessary to secure special permission from the WPB to do so. This will limit installations of electric equipment. Again, the electric motor is critical equipment and the materials in the

motor are critical, requiring a high priority to obtain them. On the other hand, the Diesel engine is also in demand for various kinds of shipping and it is difficult to say which is the more critical. When this report was written material conditions were not nearly so severe as at present, and I suggest that careful use be made of existing facilities, that they be used to the fullest extent possible, and that application for new materials be made only where a substantial need for them exists.

R. C. Bardwell (C. & O.): Mr. Hanley has covered the situation as effectively as is possible under present circumstances. We have to do the best we can with what we have, as one cannot do much in the way of getting new pipe lines, new tanks and new materials. We are confronted with the fact that the operating department wants the water delivered to engines faster than it ever wanted it before, and the engine tanks are bigger. It is important in effecting efficient operation to eliminate delays that have occurred heretofore by reason of taking water. In the past, the importance of this was often overlooked. At present, the necessity for overcoming delays is being brought right out to the front. I think Mr. Hanley has covered all these facts in a commendable manner, and there is not much that I can add.

President Dove: Are we able to get additional tanks for storage?

Chairman Hanley: Steel tanks are practically prohibited and even wood tanks require a high priority. However, it is not larger storage that is needed in all cases. It is to deliver the water from the existing

storage faster. I believe that considerable improvement can be made by installing additional supply pipes from the existing storage tanks to the water column main, as stated in the conclusions, thus securing the benefit of two smaller lines rather than one larger line.

A. B. Pierce (Sou.): I have to go to the WPB about every week to get the material the Southern requires to maintain its water facilities. The last two installations I have tried to put through had the motors marked out and notation made: "Try to get second-hand motors." Some of you gentlemen may have had trouble in getting your requests through the WPB. If you will state on your forms that you can obtain second-hand motors, they may be able to give you a priority rating on the rest of the material. I have been fairly successful in installing wood water tanks. A month ago, I was able to get five 100,000-gal. wood tanks through the WPB. We are making the lugs and hoops in our own shops; we happen to have enough material on hand to make them. The WPB gave us a priority to do so.

Mr. Hanley's suggestion to put in larger pipe to get the water away from the storage more quickly is sound. But that will not solve the problem, unless you can put the water in the tank more quickly. So to tie the two problems together, you must have a larger pump, if you are going to use the present storage facilities, which I think is a good idea.

E. M. Grime (N.P.): We have many places where it has been desirable to increase the rate of flow from water columns and usually

have resorted to one or two familiar remedies. One is to move the storage tank closer to the water column. In other cases, we are increasing the supply by installing larger pumps, but it takes a long time to obtain authority from the WPB and sufficient high priorities necessary to get the larger pumps in a reasonable time. Usually these details can be arranged, but frequently it means a long delay in the improvement of important facilities.

Where a real emergency exists, demanding an increase of the supply by additional wells or other means, the WPB has been quite reasonable in granting our requests. We co-operate to the fullest extent possible by salvaging

old pipe and fittings at abandoned water stations, by using old pumping equipment and by other practices, so as to demand the minimum of critical materials.

A. G. Dorland (E.J.&E.): It has been said that intermediate stations cannot be abandoned because of switch engines that are served. We abandoned an intermediate station at a junction point recently and are using the facility of the other railroad. Our switching at this point is mostly interchange business, and there is now only one water station instead of the two stations.

President Dove: This closes the discussion of this committee report.



Scene at a Passenger Station of the Great Western of England Following an Air Raid

Blackout and Protective Lighting

By W. G. Darley

General Electric Company, Nela Park, Ohio



W. G. Darley

Knowing that darkness is the saboteur's greatest ally, it follows that light is the railroad's first line of defense. It is not intended to infer that light, in itself, is sufficient. It is not.

It may deter intruders from entering an area, because it makes them visible if they do, but lighting should be used with other measures of protection, such as guards, fences, alarms, watch dogs, etc.

The lighting protection to be provided any property or structure depends to a large extent upon its vulnerability and accessibility. Locations along railroad tracks, near woods or underbrush, along highways, on dead-end streets, near steep banks, beside piled materials, close to bridges, or alongside docks and piers, are particularly vulnerable. Other areas that need particular attention from the standpoint of lighting are entrances to buildings and yards, spaces between buildings, and within yards, alleys and parking areas. Some general rules to follow in planning any protective lighting installations are as follows:

Provide enough light.

Avoid glare in the eyes of guards.

Avoid dense shadows.

Protect lighting equipment and wiring to minimize interruption.

Have equipment easy to maintain.

Use light color paints to increase visibility.

Avoid pointing floodlights up and down railroad tracks, rivers or roads, when possible.

Provide one or more supplementary searchlights, supplied with an independent source of power, which can be directed by guards.

Railroad bridges are particularly susceptible to attack during wartime because their destruction may interfere seriously with the rapid transportation of vital supplies for our armed forces. No amount of light will prevent a saboteur from attacking a bridge if it is not well guarded. On the other hand, guards without lights are seriously handicapped and cannot do an effective job. The important places requiring illumination are the approaches, anchoring piers, supporting piers, and the water for at least 300 ft. from the bridge. Coverage should be provided both up-stream and down-stream, so that boats or other floating objects can be detected in time to prevent damage.

Underbrush should be cleared away from the immediate neighborhood of bridge approaches to remove places of concealment. Both banks should be closely scrutinized for a considerable distance from the bridge for probable rallying points from which to

launch an attack, and these points should be kept under surveillance by periodically directing a searchlight beam on them.

In general, floodlighting is the easiest way to light a bridge. Groups of projectors are located on both banks of the stream on the up-stream and down-stream sides of the bridge, and are directed on the piers and surrounding water. In addition, however, a searchlight, under the control of a guard, should be provided to pick up any suspicious objects or movements (Fig. 1).

Piers and Docks

Piers and docks tempt the saboteur, particularly when they are important to the trans-shipment of war materials and are burdened with rolling stock. Therefore, it is often essential to afford them protective lighting. However, the

lighting afforded must be so planned that direct glare from the light source of reflected glare from the water does not interfere with navigation. To avoid such interference, local lighting is preferred to floodlighting unless the floodlights can be placed high enough or at a suitable location where glare will not present a problem.

In some sections of the country, the authorities require lighting beneath the pier to prevent small boats from harboring there in the darkness (Fig. 2). Small piers can be so lighted with vapor-proof units located under the floor; larger piers may use regular floodlights or the 150-watt PAR-38 projector flood lamps. The units are usually mounted at the water end of the pier and directed toward the land end so that inspection can be made readily by patrol boats. If the guards are to be on shore, the projectors should be



Good Dock or Pier Lighting Not Only Provides Protection but Makes for Increased Safety and Greater Efficiency Among Employees

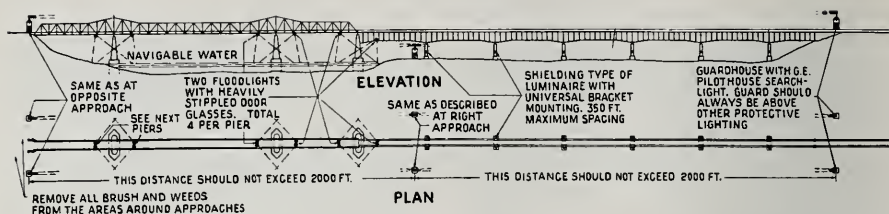


Figure 1—Bridge Approaches, All Supporting Piers, and the Water for at Least 300 Ft. from the Bridge, Need the Protection Afforded by Light. Searchlights Under Control of the Guards Should Be Provided to Allow for the Scrutiny of Any Suspicious Object or Movement

mounted at the shore end, pointing outward. In critical areas, a searchlight to sweep the water periodically helps to detect suspicious craft and to avoid the danger of attack.

Boundary Fences

Where critical areas, yards and structures can be fenced, the lighting of the fences and the areas immediately adjacent to them is usually the first consideration in a protective lighting program. Illumination along the fence lines should be fairly uniform. The points midway between units represent the most vulnerable spots, and the illumination here, therefore, both inside and outside the fence line, should be such as to make it impossible for an intruder to conceal himself, even though one of the lighting units may be out.

It is generally agreed that good uniform illumination for a distance of at least 50 ft. outside the fence line is necessary for satisfactory protection. It is also well to paint the fence white, or at least to whitewash it, as an intruder is generally more visible against a light background. If the fence is of wire netting, it should likewise be painted white, and since one can see through it, advantage should be taken of this fact to increase the guard's area of view.

Fence lighting with floodlights can be glaring to traffic and to residents. Where this condition is liable to prevail, the fence can be lighted with street lighting or with industrial types of units.

Property Entrances

The effective lighting of property entrances is very important. Lighting should be such that any-

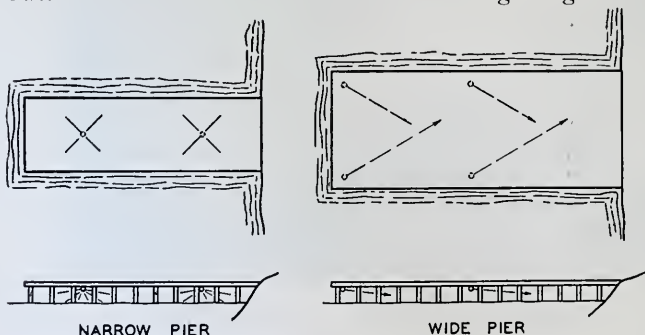


Figure 2—Protective Lighting for Small Piers Can Consist of Vapor-Proof Lighting Units Under the Floors; Large Piers May Use Regular Floodlights

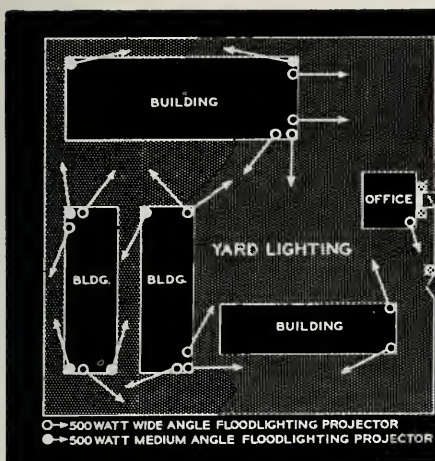


Fig. 3

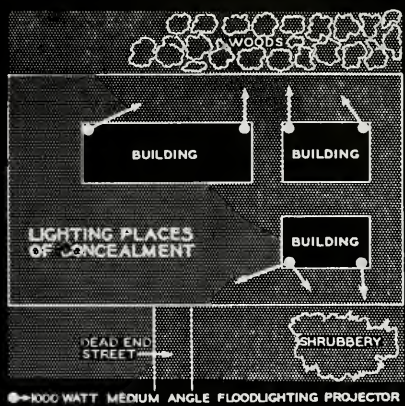


Fig. 4

Figure 3—It is more desirable to illuminate adequately the area around buildings than to light the building exteriors. Figure 4—Dangerous shadow areas and possible lanes of attack, both within and without the protected area, must be illuminated. Figure 5—For yard lighting in residential districts, units such as the Mazda projector flood or spot lamps can be used to provide a bright ring of light around the plant without much annoying stray light.

one approaching can be readily seen and scrutinized. It is advisable to provide light for an appreciable distance about the entrance so that if an intruder should rush by the guards, he would not immediately be lost to view. Floodlighting projectors on the roofs of nearby buildings can furnish effective supplementary lighting around entrances.

In addition to the general lighting provided at property entrances, it is highly desirable to provide supplementary emergency lighting by means of highpowered searchlights. These can be mounted on the roof of a guard tower or of

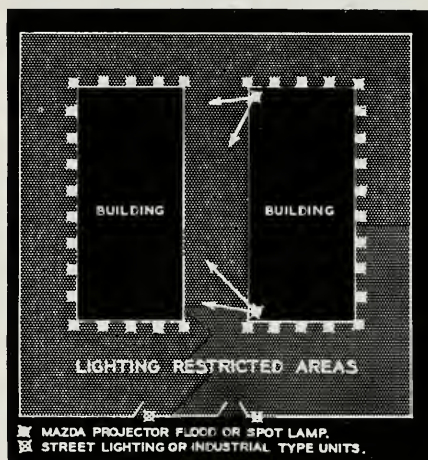


Fig. 5

some suitably located building and manually controlled from within. To be most effective as emergency sources, these searchlights should be served by a separate source of electrical power.

Yard and Sub-station Lighting

Where it is necessary to protect buildings, apparatus or stores of



Supplementary Emergency Lighting by Means of High-Powered, Directable Searchlights Is a Basic Need, Particularly for Critical Areas

important material, yard lighting must be used. This may be either in addition to or in place of fence lighting. The buildings or facilities to be protected need not be high-lighted; in fact, it is more desirable to illuminate adequately the area around them. This can often be accomplished by locating floodlights on the structures or facilities themselves, and lighting the area around them (Fig. 3).

Careful placement and direction of the floodlights are necessary to insure that the intruder, and not the guard, is subjected to glare. Care must also be taken to illumi-

nate dangerous shadow areas which would provide hiding places (Fig. 4). These requirements are usually met by means of multi-directional lighting. The necessary degree of uniformity in coverage is usually accomplished by a suitable degree of beam overlapping.

Floodlights are admirably suited to this type of lighting since they are available in a wide range of sizes with the variety of beam spreads, which permit the light to be tailored to meet almost any requirements. Lamps of the reflector type (projector flood and spot) are also available for small areas within 200 ft. of buildings.

Structures and areas located in congested districts with residents nearby have experienced complaints that the light necessary for protection shines in bedroom windows. Because these homes and yards provide excellent places of concealment, it is important that the area be lighted so that approaching prowlers can be seen easily. A good solution to this problem is to use the Mazda projector flood or spot lamps, hung vertically from the roof or upper windows of the structures to be protected on about 20 to 30-ft. centers (Fig. 5). These provide a bright ring of light around the plant without much annoying stray light. Even the small amount of normal spill light from these lamps can be screened out by using the standard spill ring shields which are available for this purpose.

Where material is stored in outlying sections of a yard, it might be quite difficult to locate the projectors on buildings and thus light around this stored material without having objectionable shadows. In such cases it may be necessary

to place units on a pole located at a strategic point. In many instances, of course, railroad yards are fitted with natural locations for such lighting.

Sub-stations are very apt to be singled out for attack. In the case of these facilities, floodlighting is required for an appreciable area around the fence, in addition to the inside maintenance lighting, where this is provided. Here it is very important to keep the undergrowth trimmed well back. This combination makes it easier to detect and deal with prowlers.

Blackout Lighting

A second phase of special railroad lighting in wartime is blackout lighting. Basically, this means that any brightness, such as direct from a light source, reflected brightness from an illuminated surface, or brightness from some process, must not be visible to an experienced dark-adapted aerial observer under the most favorable conditions.

This matter of blackout lighting has been given considerable study, and the War Department is issuing specifications as rapidly as possible on specific fields. There is a report on "Blackout of Railroads" now in the process of preparation. The specifications will be based upon tests which have been conducted during the last years in yards and army camps throughout the country. These specifications will cover specifically and in detail the treatment necessary to blackout all railroad properties, including fixed property, rolling stock, signals, hand lanterns, etc.

Air raids and blackouts are almost always mentioned in the same

breath, and yet, bombers can fly by day as well as by night, particularly where aerial defense is weak. Thus, while air raid precautions should be taken as soon as the danger of air raids is anticipated, or before, blackout (lighting) precautions need be considered for structures only where light is needed during the hours of darkness.

Naturally, some areas are more likely to be bombed than others. In fact, there are two distinct types of air-raid expectancy. One is the threat of a raid every night for an indefinite number of hours, as is the case in England. The other is the threat of a bombing any night, but not often, and for limited periods, as is anticipated at this time in this country. This second type may be subdivided into three groups: (1) Where the threat of bombing is very real or where the expectancy of air raids is highest; (2) where there is a high expectancy; and (3) where there is low expectancy.

The situation at present is not entirely clarified, and it appears, in general, that most cities in the first and second groups are preparing for air-raids. In many of these instances, local ordinances have established rules and regulations governing blackout lighting, with which it has been necessary for railway structures to comply. It is conceivable that, eventually, conformance with the national blackout specifications will be required only for structures within areas designated by the proper military authority.

In building interiors, blackout requirements may be met by one or more of the three following methods:

(A)—All light can be extinguished;

(B)—The illumination can be reduced; or

(C)—Windows, exterior doors and other openings through which light might escape can be obscured.

Obviously, where there is a low air-raid expectancy, the simplest procedure is merely to be able to extinguish all lights. This method requires that all light visible from the outside (except approved indoor blackout lighting units, which will be discussed later, and low-intensity red exit lights), be extinguished within five minutes after the official blackout signal is given, and remain extinguished for the duration of the blackout period. It would seem that large areas of the country would not be justified in going much further than this at this time. Unquestionably, this picture would be changed if any of our cities were bombed.

Those adopting the temporary precaution method, however, must always keep before them the fact that they must achieve a blackout which is just as satisfactory during an alarm as those adopting the continuous full-blackout measures. This is the first requirement, and all other considerations must be subordinated to it. Even in areas where temporary precautions are considered suitable for the majority of structures, there will be some essential operations, such as dispatching, which should have the protection afforded by special blackout lighting, or obscuration.

Controlled Illumination

The second method, and probably of widest application to railway structures in areas which are

taking blackout precautions, consists of extinguishing the regular lighting and providing a small amount of controlled illumination sufficient to permit reasonable facility of movement without necessitating complete obscuration of doors and windows. This method seems particularly appropriate where crowds might be gathered.

The War Department's specifications for the Blackout of Buildings contain general requirements for indoor blackout lighting units, and the statement is made that reduced illumination, without complete obscuration, shall be permitted only when the indoor lighting units used conform to these requirements. The requirements are:

Initial lumens—minimum $1\frac{1}{2}$, maximum 3.

Initial candlepower at any angle—maximum 1.

Light distribution—most of light in one hemisphere; in the other hemisphere, not more than 0.15 lumen.

Color—orange or orange-red.

A tungsten-filament lamp has been developed which meets these specifications. This is a 14-watt lamp. However, at present, for railroads to obtain these blackout lamps, it appears necessary to have or secure specific authorization from the director general of operations of the W.P.B.

The only present authorized use for indoor blackout units (such as these lamps) in buildings are given below:

(a) In any one room, only one unit is permitted to each 200 sq. ft. of floor area or fraction thereof.

(b) Units shall be spaced not less than 10 ft. apart in any direction.

(c) In corridors, one row of

units is permitted at a spacing of not less than 15 ft.

(d) Units shall be placed at least 3 ft. from any window, exterior door or other opening.

(e) Units shall not be pointed toward any window, exterior door or other opening.

(f) When openings are covered in the usual manner with drawn window shades, drapes or blinds, or even with one thickness of newspaper, or whenever each unit has a shade which screens it from outside observation above the horizontal, units may be installed at any height.

(g) When exterior openings are not covered, and when units are not otherwise shaded from outside observations above the horizontal, blackout units shall be located above the top of such openings.

Blacking Out of Doors and Windows

The third (and most complete and effective) method of providing a blackout is by obscuration. This consists of making all windows, doors and other openings completely light-tight, and then providing full operational lighting inside. This procedure has been adopted particularly by plants in which war production activities are carried on.

Light locks should be provided for window and doors, and for any other openings normally used for providing light or ventilation. A light lock consists essentially of a tunnel or passage having dark walls, ceilings and floor, so constructed that no direct light source or light reflected from the source is visible from the exterior at any time. Any light source inside the building near the interior entrance

of the lock should be shielded to screen direct light from entering the lock.

The obscuration of windows may be accomplished by means of paint, adhesive coverings, screens, shutters, light locks, or other approved means. Obscuration by paint alone has two disadvantages: First, that the glass may be shattered by a blast concussion and the lighted interior exposed, and, second, artificial illumination will usually be required in the daytime. In any event, the interior surfaces of windows and skylights should be painted light in color.

Adhesive coverings should be opaque and adhere strongly to the glass, and should possess considerable tensile strength. Cloth, paper or fibrous materials can be used.

Weatherproof materials should be placed on the exterior of the glass to minimize specular reflection. An advantage of adhesive coverings over paint is that the scattering of glass may not be so pronounced.

Rigid screens and shutters should fit closely in the openings or overlap the openings sufficiently to avoid light leakage. It may be desirable to hold such screens in place by flexible or electric means to absorb some of the shock of blast concussion. Various types of opaque covering, such as curtains, blankets, building paper, plywood, fibre wood or cardboard may be used. Some of the materials may be mounted on light wooden frames.

Particularly in the public areas in structures, it is necessary to have signs to direct traffic. While the normal lighting shows these up satisfactorily where the obscuration method of blackout is used, it

might often be desirable to resort to the use of phosphorescent or fluorescent materials for such signs where the lights are either extinguished or the low level of illumination is installed.

Phosphorescence and fluorescence are quite different phenomena. Phosphorescent materials are those which, having been excited to luminescence, continue to glow for some time after excitation has ceased. Fluorescent materials, on the other hand, have the property of emitting visible light while excited by an external source of ultraviolet radiation, or "black" light. Naturally, it is necessary that the ultraviolet source used for exciting fluorescent materials in the interiors of buildings shall be completely invisible outside the building. As soon as the exciting sources are extinguished or removed, fluorescent materials cease to glow. Fortunately, most phosphorescent materials also fluoresce.

Phosphorescent materials may be used to outline doors, door-knobs, switches, stairs, obstructions, elevators, railings and corridors, as well as paths to air raid shelters, rest rooms, first-aid rooms, etc. They may also be used for interior signs at locations where legibility distances of not more than 15 to 20 ft. are required.

Better grades of phosphorescent materials, in the form of decalcomania transfers, tape, paint, impregnated cloth, coated or transparent plastic, etc., will emit a visible glow in complete darkness for a period of several hours. In general, phosphorescent pigments applied by the manufacturer under controlled factory conditions are superior to those applied at point of use.

DISCUSSION

President Dove: Mr. Darley will be pleased to answer any questions you may have regarding this subject. I would like to ask one question, Mr. Darley. Is not the difference between fluorescence and phosphorescence the fact that fluorescent material will glow **only** while it is being energized by the ultra-violet source?

Mr. Darley: That is correct.

President Dove: Another thing comes to my mind in connection with railway buildings and shops. Is not the important thing to throw the lighting away from these structures, rather than on them?

Mr. Darley: Yes.

H. M. Church (C. & O.): I still do not understand the fluorescent effect you show there. It seems to me that the ultra-violet source you have on is giving off too much visible radiation. If you must have that amount of light, you would not have a blackout, would you?

Mr. Darley: Possibly not, but in practice, this relatively powerful source would be located farther away from the material and the result would be all right. The smaller ultra-violet source I have here, however, can do a very satisfactory job of fluorescent sign lighting when located close to the sign, and it would provide hardly any brightness throughout the room. The only limitation on such light sources when used for this service is that they shall be completely invisible from the outside of the building.

Member: Is that an officially approved flashlight you have?

Mr. Darley: Yes, this small hole

is just the right size according to the blackout flashlight specifications covering devices with automatic "cut-offs."

Member: Do you know what priority is required to obtain fluorescent lighting for industrial areas?

Mr. Darley: If you have an A-1-j or better, and approval to extend it, you can get equipment for fluorescent lamps.

Member: You can get the lamps without a priority, but you cannot get the equipment for using them without an A-1-j priority.

Mr. Darley: I would imagine that you can get fluorescent lighting for most areas that you are lighting for war work.

More About Blackouts

President Dove: How clear is the bomber's view of ordinary house lighting? You would not think that such lighting would be seen very easily from any great height at night. They stress that you shall black out your home so that you can go outdoors and still not see a light or a light reflection. Is it necessary to blackout as much as that to make the target invisible to the bombardier?

Mr. Darley: It is a lot easier to enforce a regulation which says that all you have to do is to make certain you cannot see any light than it is to enforce one which says that if the lighting conforms to the specifications for the blackout of buildings, it is all right. It is surprising at what high altitude actual observation indicates that you can see normal brightness in a home. You may visualize the

aerial observer as flying overhead and looking directly down. Actually, when he releases his bomb, he is at about a 45-deg. angle. So he is really observing a projection of your window which is about seven-tenths as high as it is normally and he sees a fairly large-size area of brightness. If you have a brightness greater than the requirements discussed, it can be seen. The difficulty is to try to teach the air raid warden when you are within the required brightness and when you are not. It is almost impossible to do this right now.

President Dove: How objectionable is the light emanating from radio tubes, especially if reflected against a wall?

Mr. Darley: I would suspect that not enough light gets out of a radio cabinet for reflection on the wall to be serious, but it looks like a lot, and that is the trouble. The only rule that can be applied easily just now is that the light must not be seen from the outside, so that for the time being, one will have to turn his radio off or put a blanket over it.

Member: Have these blackout lamps strung around the room been used to any great extent in the United States yet?

Mr. Darley: So far, restrictions have not permitted their widespread use. They will, undoubtedly, be given first to government buildings, to war plants and to railroads, in areas where the Army feels they should be used.

N. D. Howard (Ry. Eng. & Mtce.): Is your blackout lighting entirely consistent with protection lighting? In other words, in the

blackout, must you turn out all protective lighting, and then be subject to sabotage?

Mr. Darley: That is about right. There is a War Department specification covering street and highway lighting, but the permissible lighting is quite low and is entirely inadequate for protective lighting. One thing that we have thought about doing in our own plants during blackouts is to assign people to guard the fences. If it appears desirable to evacuate the buildings when a blackout comes, the workers can be posted at five-foot intervals along the fences. Then, if a saboteur tries to come over the fence at any point, he will be detected. Furthermore, it will give our workers something to do.

Phosphorescent Lighting

President Dove: Would phosphorescent material, used out-of-doors, be seen from any great height?

Mr. Darley: No, but the point made in the specifications for Blackout of Buildings is that the average phosphorescent effect out-doors is no more visible than a good white paint under starlight. Furthermore, present phosphorescent materials are not particularly well adapted to use out-of-doors, where, in general, they deteriorate rather rapidly.

Mr. Howard: When you say that the phosphorescent sheet retains its luminous character for a considerable period of time, what do you mean by "considerable"?

Mr. Darley: There can be a reasonable brightness up to 12 hours after the energizing source has been removed, depending a great

deal upon the energizing force. In other words, if the material was subjected to only a little light, the effect would not last very long.

Mr. Howard: Then the effect could be made to carry through the average blackout?

Mr. Darley: Yes, it could be made to carry through such blackouts as we now anticipate.

Member: Do these materials collect dust very rapidly?

Mr. Darley: The surface of this particular material has a cellophane or similar coating over the phosphorescent material. Thus, it can be easily maintained.

Mr. Howard: Is there any prospect that the specifications for the Blackout of Railroads will be out before the war is over?

Mr. Darley: I believe there is a good prospect that they will. Frankly, I have seen a copy of the specifications, but resisted the desire to study it because I was afraid I might see something in it I wanted to say here tonight.

President Dove: Are phosphorescent paints available?

Mr. Darley: Yes, phosphorescent paints are available today from many paint companies. In general, however, the paints are relatively expensive and are difficult to obtain.

President Dove: Available to anybody without any priority ratings?

Mr. Darley: I am not certain about that. I suspect they are.

Member: There are a couple of concerns in New York; one in particular, that has been in business for many years, dealing with the stage trade. You do not need

any priority to get the material from them. I do not know whether ultimately some restrictions may make it necessary to have priorities to get certain colors, but most of them are readily available now if you have the money to pay for them.

President Dove: Does the phosphorescent paint retain its brightness very long?

Mr. Darley: Reasonably long.

President Dove: That would be the sort of thing to be used on the doorsteps or doorknobs.

Mr. Darley: Possibly not on the knob, because it would soon be worn off, but it could go around the knob. What we have done is to cut phosphorescent sheeting into strips and lay out a square on the door around the knob.

Member: It would be well to paint the keyholes.

Member: Has an automobile headlight for blackout been developed?

Automobile Lights

Mr. Darley: Yes, I have one here. This is the regular standard lighting. Here is the blackout lighting. You can drive with a relative degree of safety at 15 m.p.h. with this amount of illumination.

Here is the tail lamp. It has four lighted dots on it. If you have normal eyes and get back about 180 ft. or more, you can see only one dot; if you get up somewhere between 60 and 180 ft., you see two dots; and if you get up to within 60 ft., you see four dots. It helps you to tell how far you are away from the unit.

Here is the stoplight and here

are the indicator lights for the front of the car. These developments have been coming along very satisfactorily and the units will be available to authorized agencies.

Mr. Howard: Has anything special in the way of lighting been developed for railroad grade crossings?

Mr. Darley: The answer to that question will undoubtedly be found in the specifications for the Blackout of Railroads.

Member: Are there blackouts on any railroads, such as in dispatchers' offices, where completely opaque slabs are kept readily available to be put over all windows?

Mr. Darley: You refer, I believe, to complete blackout while maintaining normal lighting, so that the men can see to do their work. I expect that in many vital areas this will be the answer.

Member: We have all of our important places covered that way.

Mr. Howard: You mentioned the shattering of merely painted window glass. Obviously, if a building is demolished by a direct hit, the glass would shatter in all directions, but with a near explosion outside, does the glass shatter inward or outward?

Mr. Darley: I believe it is nearly unpredictable. Sometimes it goes in and sometimes out.

Member: Would not the painted glass act more or less as a mirror anyway in reflecting any light there was outside?

Mr. Darley: With a vertical surface, it does not make much difference whether it reflects or not,

because all an observer overhead sees reflected in the surface is the ground. If you have a tilted surface, however, as you do on many monitor roofs, then you would want to paint the outside of the glass rather than the inside because of what you say.

Member: Why would it not be possible to have a light camouflage? Take Detroit, for instance. Why couldn't it be so wired out in the country that you have a city camouflaged out there? Let a little light appear here and there as though it might be the city, and keep the city blacked out during that time.

Mr. Darley: There are various thoughts along the line of using light to deceive the enemy. The principal difficulties are the material that it would require, and the fact that, as was indicated on one of the slides, it is very difficult to conceal a quirk in a river, for instance; and many of our more important cities are located on rivers.

Another somewhat similar idea has been to have a glare barrage; that is, to have many lights in the city directed up into the eyes of the fliers, thus reducing their ability to distinguish detail. But the trouble with this idea is that huge areas must be involved, because if it is decided to save a certain terminal by a glare barrage, unless a large area is included, all that is done is to make it easy for the enemy to find the terminal.

We understand that the Germans tried the idea of putting up a false city outside of Berlin. I do not know whether it fooled the R.A.F. or not.

Mr. Howard: Does concrete pave-

ment reflect readily on a moonlight night?

Mr. Darley: Yes, white concrete pavement would be fairly visible.

Mr. Howard: I was just thinking about our terminal areas. There is a lot of pavement around them, even highways. I wonder if any of them have been treated with a bituminous material to give them a darkened appearance?

Mr. Darley: I do not know whether they have or not. It is possible that this will have to be worked on, because on a moonlight night a large area of relatively white concrete, contrasted to dark earth, would be readily visible.

Member: The runways are painted green at all of the airfields on the Coast.

Mr. Darley: That fits right into Mr. Howard's comment.

Mr. Howard: Will railroad rails show up on a moonlight night?

Mr. Darley: To some extent, yes. You see, they have a convex surface, more or less, and if they are in a certain position with regard to the moon, it is possible to pick up a light glint. It is amazing how much you can see at night. You can actually see terrain configurations.

President Dove: Mr. Darley, we certainly wish to thank you for your address tonight and for all the equipment and apparatus you have brought to us. It has demonstrated what you had to say very clearly. I know I express the opinion of everyone in this room, and of all those who had to leave early, when I say that we thank you for your demonstration and address.

The Protection of Railway Structures In Time of War

By B. R. Kulp

Chief Engineer, Chicago & North Western

(Introduced by President R. E. Dove)



B. R. Kulp

President

Dove: Being acutely aware of the war that now prevails, your Arrangements committee recognized that there was an active interest on the part of our members in protect-

ing our key structures during a time when so much depends upon the free flow of traffic, and when it would be extremely difficult to obtain the necessary labor and materials to replace them if damaged or destroyed.

Last year, we had the pleasure of hearing E. P. Coffey, chief of the Technical laboratory of the Federal Bureau of Investigation, who addressed us on The Protection of Railway Structures Against Sabotage. Mr. Coffey's address was necessarily of a general nature, and, since our nation has become actively involved in the war, and owing to the fact that a year has transpired and more experience has been gained, our desire for more specific information on this subject has been intensified. The North Western has many important bridges, terminals, docks and similar structures, and its chief engineer, B. R. Kulp, has graciously

consented to address us on the conclusions it has reached that will be of help to us in the protection of our structures in wartime. It is a pleasure to introduce Mr. Kulp.

Mr. Kulp's Address

The protection of railway structures is an important matter at any time, but particularly so in time of war. The transporting of men and materials is largely dependent on the railroads, and to keep their lines open for operation is one of your jobs as bridge and building men. To do this is no simple task, and in time of war it is doubly difficult. Even though you have the assistance of federal, state and civic bureaus, together with that of other departments of your own roads, in this work, much of the responsibility rests on you. You are the ones who will have to explain why this or that could have happened.

Communications Vital

All military tactics and strategy are based on the maintenance of communications. Armies whose communications are cut or interrupted seriously are in a hopeless position. The maintenance of communications is so far-reaching as to include the source of supply and the means of transportation to the

ultimate theatres of action. In a war economy, the transportation of troops and war materials is just as important to victory as the successful field operations of the armed forces. To assure this continuous movement of men and material, the nation looks to us to do our part.

The greatest threat to this uninterrupted service is sabotage. Since the end of World War I, the people of the United States have almost forgotten the dread implications of this word. Again, however, we are faced with the fact that sabotage is a serious threat to our war efforts. I have no desire to stir up hysteria on this subject, but we must look at it in a calm, business-like way, realize the existence of this potential menace, and be prepared to detect, combat and frustrate it.

America's experience during World War I proves that we have many vulnerable targets for those intent on sabotage. In our field, the objectives of the enemy include railway bridges, freight depots, docks, power plants, interlocking plants and freight classification yards; in fact, anywhere where large quantities of rolling stock and lading are concentrated.

From the activities of the Federal Bureau of Investigation, it is reasonable to assume that our enemies are well established in this country for carrying on subversive activities, using every opportunity to disrupt production and transportation. **They must not be under-rated.** They employ intelligent technique and ingenuity in their methods, and are daring beyond question. Examples of this were publicized recently in the newspapers when enemy agents were

landed from submarines. They were equipped with destructive materials and plans for the destruction or disruption of specific plants and structures of great importance.

Major Protective Measures

The major protective measures that can and are being employed are as follows:

(1) Investigation and identification of employees by badge and photograph, together with the filling out of questionnaire forms and the taking of fingerprint records on F.B.I. forms, including a small-size front view photograph. Copies of these fingerprint records are filed with the F.B.I. at Washington, D.C. This procedure is used only at certain important locations, such as docks, terminals, etc. The questionnaire form used is comprehensive in scope and provides an excellent history record of an employee and his relatives. The forms are carefully reviewed and filed for reference. Only authorized persons are permitted access to these records.

With regard to the identification of employees, some railroads are requiring all employees on their properties to wear badges, on which are printed small-sized photographs of the holders. Authorized visitors are also required to wear badges while on the properties.

(2) The erection of high wire fencing, where practical, to enclose vulnerable areas, confining the entrances, where possible, to one common gate, where a guard (in most cases armed and deputized) is on continuous duty with authority to admit no one unless prop-

erly identified, and to open and examine all packages. A gate shanty is provided, with telephone service for liaison and reporting purposes. Wherever such gate controls are maintained, a log record is kept of all persons entering or leaving, other than employees.

(3) Floodlighting, where practical and necessary, is used as an effective means to discourage and control trespassing, and to assist guards and watchmen in the performance of their duties. This form of protection, however, requires careful consideration and study before employment, since in some cases it can attract and emphasize the importance of a structure. Some of the benefits of this type of protection include the blinding effect on trespassers, the exposure of anyone entering the lighted area, and the ability of guards to remain concealed. Power houses and outside power and lighting transformer banks are extremely vulnerable and important to the continuous operation of plants and terminal facilities, and should be given special consideration.

(4) The use of armed and deputized guards, or watchmen, roundsmen and roving agents, at vulnerable areas and at important bridges, other structures and terminals. All guards, roundsmen, watchmen and employees on duty at important bridges and other structures are drilled and instructed in the control of unauthorized persons entering the property, and in the prevention and fighting of fires. All suspicious persons or equipment on or adjoining railway property are immediately reported to special agents for investigation.

Foot patrol roundsmen, covering specific areas on regular rounds, are usually supervised by the recording of their trips at clock key stations located at established places throughout the area or property being patrolled. In most cases guards, roundsmen and special agents are under the jurisdiction of the chief special agent, who pro-



Important Freight Classification Yards Must Be Protected

vides the essential contacts for co-operation with municipal, state and federal police and intelligence services.

Fire Hazard

Because of the combustible composition or content of many structures, fire is the principal hazard. Such structures should be studied carefully and suitable fire extinguishing equipment and other appropriate fire-fighting apparatus should be provided. This equipment should be inspected frequently against tampering and to

insure proper maintenance, so that it will be ready for immediate use in an emergency. Vegetation, rubbish and inflammable waste or scrap material should never be permitted to accumulate on or adjacent to combustible structures. A high standard of housekeeping should be maintained in and around structures at all times. This will minimize the normal fire hazard and chances of fire by acts of sabotage.

All recommendations of the various fire prevention services for the



Important Bridges Should Be Guarded

improvement of protection and the elimination of hazards should be carefully considered and checked with the thought of providing the maximum of protection and minimum of hazard. Fire drills should be conducted periodically. Water mains, valves, pumps and other protection equipment should be tested frequently, and all authorized persons should be thoroughly instructed in their use to avoid confusion and delay during an emergency.

Fire prevention and protection activities on the railways are under

the jurisdiction of the chief fire inspector, who maintains the essential contacts for co-operation with municipal, state and national fire associations and services, and who also collaborates with the chief special agent's department where interest is joint. Wherever explosives are stored or used, special locks should be provided for doors, and one man should be held responsible for the distribution of the explosive and for the control of the keys to the facility.

Care should be exercised in the distribution of switch and master keys, and a careful record should be kept of those to whom keys have been issued. Men leaving the service should be required to turn in any such keys, together with their identification badges. Extreme care should be exercised in the distribution of drawings, blueprints, correspondence or information which could in any way help the enemy. In this regard, blueprints, drawings or maps of underground water mains, control valves, electrical conduits, etc., are of unusual importance. Information pertaining to train movements, class of equipment, tonnages and types of lading being handled, or troops carried, should never be disclosed or discussed unless necessary, and then only with authorized persons.

In some instances, governmental organizations will undertake the protection of certain essential structures or facilities, but only after private industry has been unable to cope with the situation adequately.

The F.B.I. is very co-operative and has aided our road greatly with suggestions on our protection

problems. Its forces are trained to investigate sabotage or attempts at such. It is important, therefore, that you see that your personnel reports to you promptly any attempt at sabotage, or any irregularity which may indicate such an attempt, regardless of how small. You, in turn, should lose no time in relaying these reports, with all details and the results of your investigation, to your superior officer, so that he can bring them to the attention of the F.B.I.

In closing, permit me to stress the importance of unending vigilance at all times, and that employees should not hesitate to question or to report the presence of strangers encountered on railroad property. Vigilance in time of war is a definite duty of all railway employees. It is particularly the duty of you engineers and bridge and building supervisory officers, as in the carrying out of your duties in the field you are in a position to notice irregularities or places where acts of sabotage could be attempted. Then too, you are charged with the employment of greater ingenuity and alertness in the protection of strategic and vital structures. And remember, the same alertness and enthusiasm you expect in your men must be ever evident in yourself, or you will fail to inspire them.

DISCUSSION

President Dove: Mr. Kulp has consented to answer any questions you may have on this subject; I want to ask one myself. Mr. Kulp, to what extent do these governmental agencies co-operate in the protection of these structures? Is

it not a fact that most of this work is done by your own forces?

Mr. Kulp: That is practically true. We have Coast Guards at one of our ore dock properties at Escanaba, who have taken over the complete job of protection. At our ore dock property at Ashland, we, after several months of endeavor, awoke one morning to find the State National Guard had appeared on the scene, and they are giving some protection, but not full protection. At the dock property at both of these locations, the Coast Guard has provided fire protection and is using guard boats along the waterline. We had State protection on some of our Mississippi River bridges and on certain of our other very important bridges, but only for short periods, so advice and co-operation is about all we get now. They will assist in any investigation that we may be making.

President Dove: Another question, Mr. Kulp. Who determined what protection these structures will have? In other words, what office?

Mr. Kulp: On our railroad, it was the chief operating officer, the chief engineer, and the chief special agent. The three of us, as a rule, went over these various structures in conference and decided what we had to do.

W. A. Huckstep (M. P.): Would you welcome a suggestion from a bridge and building man, if he should see some facility which he thought should have added protection? For example, you might have a vitally important pumping station that such a man might think it well to have fenced in order to keep people out.

Mr. Kulp: The bridge and building supervisors on my railroad are always welcome to make a suggestion, and I think that is true on all roads. After all, I tried to make it clear that you men are in the field. You are out continuously where you see things we in the office do not see. We must have suggestions from you, and we must have you watching for activities that might result in trouble.

Mr. Huckstep: I put that inquiry just a little wrong. Naturally, suggestions are welcome, but I mean, is it the desire that they keep on the alert for such things now, and report promptly, rather than wait?

Mr. Kulp: I think they should be alert, even though they might make 25 suggestions or recommendations and 24 of them are tossed out the window; one of them may be vital.

Methods on M. P.

L. G. Byrd (M. P.): I should like to state the practice on the Missouri Pacific Lines. We selected several of what we consider our most important structures, giving due consideration to their location, that could be damaged or destroyed easily and quickly, and placed guards on them. On the Missouri division, we have five such bridges, and on the Memphis division we have six. These bridges are generally in obscure places—hidden in the woods or away from communities. We have night guards put on by our special agents.

On one or two different occasions, we have found the F.B.I. has been very prompt in giving its assistance and in running down clues.

Recently, we had a bridge destroyed by fire between Wynne and Bald Knob, Ark. The F.B.I. was notified and two agents came immediately to the site and went into all of the details with our special agent, the roadmaster, the bridge and building foreman and me, to see if there was anything that would indicate sabotage. They stayed on the problem for several days, in spite of the fact that only a very short structure was involved. They investigated everything they thought might have had a bearing.

We also had a false alarm out at Poplar Bluff, Mo., about 10 or 12 miles north. A man reported to me in my office at Poplar Bluff that he had seen a man out on the track at a certain point along the Black river, using a claw bar. I notified the special agent, and he got in touch with the sheriff and others to assist in the investigation. They very promptly ran it down and found out just what was involved. In this case, it happened that the man who made the report had been gassed in World War I, and was subject to seeing things.

G. S. Crites (B. & O.): Two cases of witch-hunting have been brought to my attention. One case involved fish-dynamiters, who left percussion caps under a small bridge, and in the other case, 26 spikes were found piled on a bridge guard rail. Berry pickers had found some loose spikes where rail was being laid, and had kindly gathered them up and put them on the guard rail so that they might be salvaged.

President Dove: Well, Mr. Kulp, allow me to express the appreciation of the association for your very pertinent remarks.

Rail Fastenings on Bridges, Pits and Turntables

Report of Committee

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John S. Hancock
Chairman

This report was developed chiefly from information obtained from members of the association by means of a questionnaire, replies being received from railroads aggregating 135,000 miles of lines.

In considering the subject of rail fastenings on bridges, pits and turntables, the method of supporting the rail on the structure and the anchorage of this support to the structure assume major importance. It is imperative that the rail have an adequate and well-anchored support, otherwise any type of rail fastening will prove unsatisfactory.

One of the most satisfactory methods of supporting track over bridges is by means of a well drained ballast deck. Such construction gives riding qualities similar to the track on the embankment, which is highly desir-

able. Also, the track is maintained by the regular track forces, which is a distinct advantage. For construction of this kind, the rail supports and fastenings are the same as on the approaches.

On open-deck bridges the use of the time-tested timber bridge tie is still the most satisfactory method of supporting and fastening the rail.

It is apparent that the railroads are not in exact agreement as to size and spacing, method of dapping, or practically any other detail of bridge ties. Railroads using similar equipment and with similar train speeds apparently derive equal satisfaction from different standards.

Size of Bridge Ties

The size of ties for open-deck steel bridges varies, of course, with the center-to-center spacing of the stringers or girders supporting the ties and the live load weight to be supported. Tie spacing is not subject to much variation because, if spaced too far apart, the ties will tend to bunch in a derailment due to the wheels dropping down too far below the tops of the ties, while, if spaced fairly close together, the wheel flanges will tend to run along on top of the ties without dropping down enough to force the ties to bunch. Oak bridge ties with a

6-in. clear spacing between ties have carried derailed cars across the full length of sizable bridges without bunching the ties.

Preframing Bridge Ties

When ties are framed before treatment for either steel or timber structures, several details must be considered. For steel structures, the exact width of the steel flanges can be determined in the field or from plans. Field measurements, however, are preferable. On timber bridges, the width of dap will depend upon whether the timber stringers are S4S or rough dressed. Rough dressed stringers may over-run as much as $\frac{1}{4}$ in. each, and allowance must be made for this over-run. If ties are to be pre-bored for track spikes on new construction, the steel must be set on the correct centerline; otherwise the track will be out of line. On existing structures, the correct centerline must be marked on the old ties, field measurement taken to the steel flanges from this centerline and the ties framed accordingly. Each tie is then numbered as to its correct location.

On steel structures, no railroad reported dapping more than $\frac{1}{2}$ in. wider than the steel flange, and some allow a total of only $\frac{1}{4}$ in. wider than the flange. Where a wide dap is used, alternate ties should be driven tight against the steel flange in opposite directions before the rail is spiked, provided the ties are not prebored for track spikes. If ties are not dapped for rivet heads, these rivet heads, depressed into the tie, will assist in holding the tie to line. By careful field measurements and accurate shop framing, close fitting prebored ties can be obtained and are recommended if creosoted ties are to be used.

A tolerance of $1/16$ in. is usually the maximum permitted in the depth

of tie dap required. Mill framing is highly desirable, because of the accuracy of such work. However, several railroads still permit hand dapping.

When using dapped ties on steelwork, most railroads use $\frac{3}{4}$ in. or $\frac{7}{8}$ in. hook bolts in every third or fourth tie to anchor the ties to the steelwork. Also, on timber trestles, dapped ties are usually bolted, drifted or spiked to the wood stringers at every third or fourth tie. However, at least three railroads depend entirely upon the tie dap to anchor the ties on both steel and timber structures. The use of hook bolts or equal devices on steel, and drifts, bolts or spikes on timber trestles, gives additional stability to the dapped tie deck that is particularly desirable in case of a derailment.

The Chicago, Milwaukee, St. Paul and Pacific reports some dissatisfaction with hook bolts to anchor ties to steelwork and now use a proprietary type of bolt with a lug washer and double coil steel spring. With undapped ties on steelwork, every second tie is anchored on tangents and every tie on curves. However, a few railroads anchor-bolt only every third or fourth undapped tie to the steelwork. For undapped ties on timber trestles, the Baltimore & Ohio spikes one end of every tie on tangents, alternating the ends of adjacent ties, and spike both ends of the tie on curved track, using $\frac{1}{2}$ in. by 12 in. boat spikes. The Illinois Central makes every sixth tie a key tie on both steel and timber structures, this key tie being 2 in. deeper than the intermediate dressed ties. The key ties are dapped 2 in. to engage the steel flanges or timber stringers. On steel bridges, these key ties are hook-bolted to the steelwork, and on timber trestles they are bolted to the stringers. For timber trestles, the Canadian Pacific spikes each tie

to the outer stringer with $\frac{3}{4}$ in. spikes. Also, ties over bents are bolted to the caps.

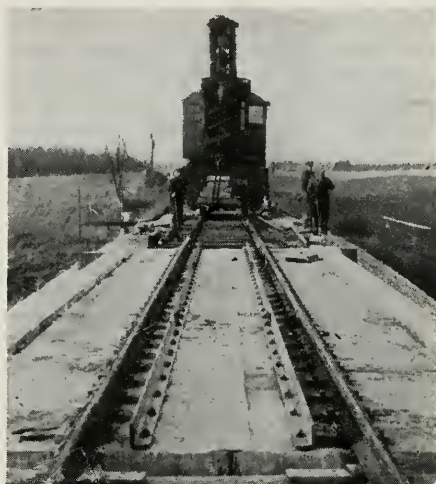
The bolting, drifting or spiking of ties to stringers is an unsatisfactory detail that no one has, as yet, corrected except by complete elimination. It is hardly practical to prebore the stringers, for this hardware and the use of such hardware without preboring provides an entrance for water and fungus into the untreated portion of the stringer. Until this detail is improved, the best that we can do is to use the outside stringer for this hardware in order that the removal of decayed stringers, when necessary, will not be unduly difficult.

Where there are only two lines of rivet heads in the cover plates, ties may be dapped for rivet heads. However, with four lines of rivets, such dapping seems impractical. Many railroads report no dapping for rivet heads, permitting the first train over the structure to settle the rivet heads into the timber, slowing the train down to 10 to 15 miles an hour. For pine and fir ties, which are widely used, this is a very effective way to take care of rivet heads, as dapping for them is expensive and decreases the strength of the tie. Oak ties, however, may require more than one train to settle the rivet heads into the timber.

Fastening Ties to Stringers

The Michigan Central prefers to dap for each rivet head, which in some cases precludes framing before treatment, or else cutting grooves the full width of the tie for each rivet line, as it considers that rivet heads will not sink readily into the timber, particularly if the timber is somewhat knotty. The Canadian Pacific; Chicago, Rock Island & Pacific; Northern Pacific; Chicago, Milwaukee, St. Paul & Pacific; Great Northern; Chi-

cago, Great Western; Detroit, Toledo & Ironton; Missouri-Kansas-Texas; Elgin, Joliet & Eastern and Chesapeake & Ohio do not dap for rivet heads, permitting a locomotive crane or the first train over the bridge, at reduced speed, to press the rivet heads into the tie. For this practice the track must be securely anchored to line as



The Canadian National Was a Pioneer in the Use of Heavy Malleable Iron Plates and Clips for Fastening the Rails Directly to Concrete Bridge Decks

there is a tendency for the track to shift on rivet heads, and if the track is once seated out of line, it is difficult to restore it to correct line.

The New York Central; Canadian Pacific; Chicago, Rock Island & Pacific; Illinois Central; Chicago, Milwaukee, St. Paul & Pacific; Pennsylvania; Baltimore & Ohio; Missouri-Kansas-Texas; Delaware & Hudson; Erie; Chesapeake & Ohio and Detroit, Toledo & Ironton frame and bore timber partially or completely before treatment. Several roads omit preboring of creosoted ties for track spikes. However, it is believed to be practicable and economical to prebore

for track spikes as the additional penetration of creosote at the point where the tie is most severely used will materially increase the life of the tie.

Many tie plates are so designed that the center of rail lies inside the centerline of the plate. The plate then tends to settle into the tie more deeply at the inside edge than at the outside edge, insuring tight rather than loose-gage track. In using 112-lb. rail, one railroad reports preboring and spiking the track $\frac{1}{8}$ in. wider than standard gage to eliminate tight gage track. No other railroads, however, prebore for other than standard gage and obtain satisfactory results.

Most of the railroads reporting place bridge ties without interruption to traffic, except for slow orders during working hours, generally replacing all ties at one operation, although an occasional spotting in of a new tie to replace a defective one is permitted until a complete out-of-face renewal is required or justified. The patching in of ties tends to make a rough track.

Hand derricks mounted on push cars are very useful in placing ties. Maintenance cranes and locomotive cranes assist in speeding up the work and air or electric wrenches or drills are very efficient and highly desirable tools in speeding up the work.

Most railroads change out ties during both summer and winter. However, some confine this work to the winter months, leaving the summer for work not suitable for cold weather. One objection to changing ties in winter is that frequently the top flanges of steel structures are damp and cannot be coated properly. In the Arizona, New Mexico and Nevada territories, where the temperature gets much over 100 deg., tie renewals are scheduled to avoid these periods of the year.

No major difficulties are reported during the process of replacing ties. Good practice requires the placing of

a slow order to protect the workmen and operation of trains. The Milwaukee railway slows trains down to about half the normal speed. The New York Central does not issue a slow order except on major structures, when a bulletin is issued covering certain working hours, during which time a flagman is used. During other hours, track is left in condition for usual speeds. Local conditions, of course, determine the protection and speed requirements at the time of the renewals. In multiple-track territory on large structures, it is desirable that service be taken off the track on which ties are being replaced.

On steel structures having a camber approximately equal to the deflection caused by the train loading, bridge ties may be dapped or framed the same depth for the full length of the steel. It will be found, however, that some spans have considerably more camber than will be deflected out by the train loading, in which case it is possible to obtain better riding track by removing excess camber in the tie framing.

The Missouri Pacific has for some time butt-welded the rail on all open-deck bridges at such time as new rail is laid over the structure and finds this practicable on heavy and high-speed lines. Welded joints should add materially to the riding qualities of the track and reduce impact stresses in the bridge structure.

The Milwaukee reports that, as open-deck floors come up for renewal on its main lines where traffic is heavy and fast, they are replaced, if possible, with creosoted-timber ballasted floors.

Tie Plates and Spiking

All railroads report the use of tie plates on open-deck bridges similar to those used on embankments. For heavier rail, double-shoulder plates are in universal use.

For holding track to gage, the hold-down spike is more effective than the rail-holding spike. These hold-down spikes are also very effective in preventing plates from shifting on the ties, which adds materially to the life of the ties, as this shifting of the tie plate is an important factor in the mechanical wear of ties. Due to the deflection or working of the rail, the rail spikes are partially withdrawn from the tie and the spike holes for the rail spikes are subject to considerable wear, decreasing the effectiveness of rail spikes. Since the head of the rail spike is somewhat above the base of the rail, due to the working of the rail, it offers less resistance to horizontal movement of the rail than the hold-down spike whose head is driven tight against the plate. The holes in the plates for the hold-down spikes fit more tightly than those for rail spikes, permitting both hold-down spikes to resist better the tendency of the track to spread. The ratio of resistance of hold-down spikes to rail spikes in preventing the spreading of track increases with the life of the tie as the rail spike gradually loses its holding power in the wood.

Screw spikes are very effective as hold-down spikes. They are, however, more expensive to install and maintain and require additional special tools for their installation and maintenance. The heads of the screw spikes also tend to corrode to the extent that they do not fit the wrench socket and the threads sometimes freeze in the wood so that they cannot be tightened without breakage. In using screw spikes as hold-down spikes, it is recommended that double coil spring washers be placed between the plate and the head of the screw spike to take up the withdrawal action and hold the plate tight against the tie. Such spring washers also decrease the tendency of the spike to tear out the

wood fibres holding the spike, which adds much to the value of the spike, for when the wood fibre surrounding the thread is once damaged, the screw spike loses its effectiveness.

Replies to our questionnaire indicate that not many railroads are using special type fastenings, but those which do, express satisfaction with their use. In general, however, the opinion is that the benefits to be derived from special type fastenings are not commensurate with the increase in the first cost except when used for special installations.

Rails Fastened Direct to Decks

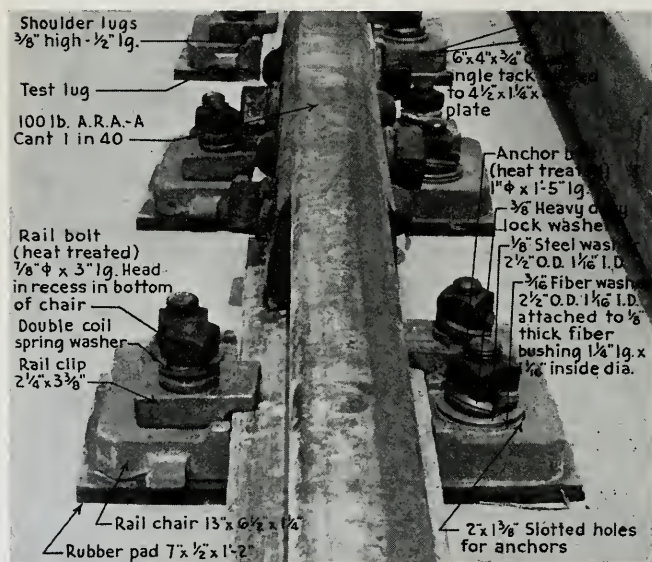
One of the most important and recent developments in track fastenings is the anchorage of the rail direct to steel and concrete structures on main-line high-speed tracks. Not many of the railroads replying to our questionnaire have had experience with this type of fastening on main line tracks. Much detailed information has been published recently on this development, however, and, as this information is readily available to anyone concerned and is published in more detail than it would be possible to include in this report, we will make no effort to duplicate it here.

C. P. Disney, bridge engineer of the Central region of the Canadian National, is a pioneer in the development of an excellent fastening for securing rail direct to main-line bridge decks by means of heavy malleable iron rail plates or chairs and clips. In this design the heads of the $\frac{7}{8}$ -in. by $3\frac{1}{2}$ -in. bolts securing the rail clips to the rail plate are countersunk in the rail plate and the 1-in. diameter bolts anchoring the rail plate to the concrete have no contact with the rail. A $6\frac{3}{4}$ -in. by $\frac{1}{4}$ -in. by $12\frac{1}{4}$ -in. rubber shim, with $\frac{1}{2}$ -in. round holes for the 1-in. hold-down bolts, is placed between

the concrete and the rail plate as an insulation to prevent short circuiting on signal track. In a letter dated February 23, 1942, Mr. Disney writes: "After 20 years' experience, I can state definitely that there is only one satisfactory method of attaching rails directly to concrete or steel decks, and that is by the use of a well-designed heavy malleable iron plate and clips. This method has proven 100 percent satisfactory. We have hun-

ordinary construction, the advantages may quite often outweigh the disadvantages, and for special construction, where many adjacent tracks have to be elevated to accommodate a grade separation structure, economy demands the anchorage of the rail direct to the bridge deck. The main advantages of this type of rail support are:

(1) A saving of 15 in. to 18 in. in the headroom ordinarily required



Type of Rail Support Recently Employed on Bridge of the Grand Trunk Western (Canadian National) at Flint, Mich.

dreds of bridges with this type of deck, and in no instance have we had a suggestion of trouble or failure of any portion of the installation. Once it is installed, it apparently is permanent and requires no maintenance whatsoever." Mr. Disney also advises that this type of fastening has been used at a number of points to secure their rail on engine pits and the circle rail on turntables.

Although there are disadvantages in anchoring rail directly to steel or concrete decks, it is believed that for

for ballast and ties. This can be particularly important on grade separation structures in cities or at locations adjacent to yard tracks where large-scale track raising or lowering of city streets, drains and sewers are involved.

(2) No timber ties to be renewed or tamping of track or cleaning of ballast required.

(3) Better drainage of the bridge slab.

(4) No accumulation of dirt on the track as the concrete surface can

be kept clean by sweeping or washing.

(5) A marked saving in the cost of the main span due to the elimination of the ties and ballast, thereby decreasing materially the dead load to be carried by the structure.

Some of the disadvantages advanced for this type of construction are:

(1) Care is required to set embedded type anchor bolts for the plates to give good track alignment, and locating them so they will not touch the reinforcing steel. The Canadian National reports that they have no difficulty in placing these bolts as they now use a cinch bolt and drill the holes for these bolts while the concrete is still green.

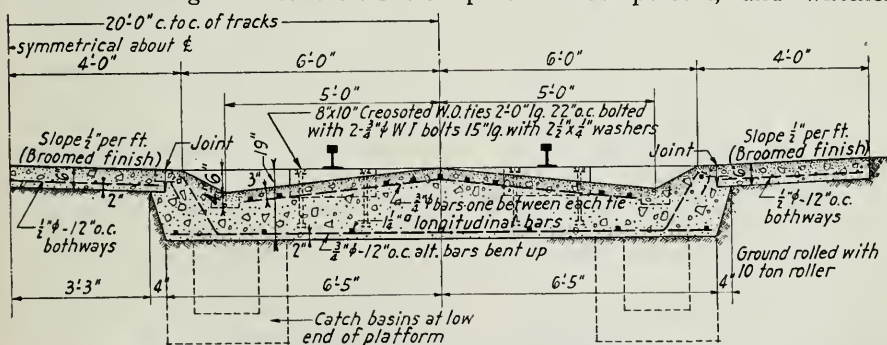
(2) Different riding qualities of the track on the bridge as compared with adjacent ballast sections.

(3) Difficult to change alinement or grade of track after the bridge is constructed.

On a Grand Trunk railroad structure built recently at Flint, Mich., where this type of fastening was used, a reinforced concrete sub-ballast transition slab, 10 ft. wide by 12 in. thick and 12 ft. long, was placed at each end of the bridge, with its forward end resting on a concrete shelf

one foot wide at the back of each abutment, and the other end resting on crushed stone ballast. Also, to accommodate the greater wave motion of the rail near the abutments, rail bolts for the first few plates on the slab were not tightened as much as the remainder of the rail bolts on the slab. Rail plates on this structure were placed at 21-in. centers to accommodate 100-lb. R.A. rail. The rail of one track over this structure was welded continuous over the bridge, standard joint bars being also installed at the joints. The rail in the other track is not welded, having standard joint bar connections, this in order to secure a comparison of the riding qualities of the two types of joints. To date no distinct difference is apparent in the behavior of the two types. As this structure is located in automatic signal territory, a careful check was made to determine if there was any tendency towards signal current leakage but in no case was leakage of electrical current detected.

For those of us who have had several years' experience in maintaining concrete structures that have been in service for 15 years or more, there arises the question as to what will be the satisfactory life of a comparatively thin concrete deck that is not waterproofed 100 percent, and whether



Use of Tie Blocks to Support Track on Wash Platforms on the Pennsylvania, at Harrisburg, Pa.

track anchorages secured to slabs not waterproofed will prove satisfactory over a long period of time.

It is very evident that the service life of rail chairs or plates anchored to steel decks will depend upon the life of the fastenings and steel involved. However, when secured to a concrete deck, their life might be limited to the life of the concrete to which they were anchored. For those who consider anchoring rail direct to concrete, it is recommended that they give serious consideration to thoroughly waterproofing the deck slab if it is to be subject to snow and ice with frequent freezing and thawing.

Concrete, as now used, is a porous material and will absorb approximately 10 percent of water by volume. The freezing of this absorbed water causes spalling of the concrete. Much research is now in progress to eliminate this trouble, particularly by the state highway departments. A few states are using a new type of cement in their pavements to prevent this scaling and spalling. Others are experimenting with a surface waterproofing like boiled linseed oil. However, so far, this is experimental. Until such time as concrete is made more resistant to weathering and freezing and thawing, we are of the opinion that any flat concrete surfaces that will retain snow and water, to which track fastenings are to be attached, should be waterproofed. However, here again, we must admit that the Canadian National reports that they do not waterproof their bridge slabs and that they have had no trouble with their type fastenings due to disintegrated concrete over a 20-yr. period.

For locations requiring the installation of a flat timber on pit walls or bridges, the track being fastened to the timber with standard track fasten-

ings, an 8-in. by 16-in. creosoted timber placed flat has proven satisfactory, the timber being anchored to the wall or deck by 6-in. by 4-in. angles, one on each side of the timber with the 6-in. leg up, the timber being secured to the angle iron with $\frac{3}{4}$ -in. by 6-in. lag screws spaced to clear the track spikes. The 4-in. leg of the angle is anchored to the wall or deck by bolting.

The Milwaukee and the North Western report the use of a proprietary type of fastenings for anchoring rail direct to steel bridge decks. They have experienced some trouble in securing perfect insulation between the rail and the steel in signal territory and trouble in shimming when required to bring the track up to surface.

Engine and Cinder Pits

Track can be anchored adequately to steel and concrete pit walls in many different ways.

On engine pit walls, the Chesapeake & Ohio uses 8-in. by 1-in. by 12-in. bearing plates laid directly on top of the pit walls at 18-in. centers for 100-lb. rail. The rail is secured to the bearing plate by heavy rail clips. Bearing plate and rail clips are secured by $\frac{3}{4}$ -in. V-stirrup bolts imbedded 16 in. into the concrete wall. For slow-speed tangent track, anchorages like or similar to the above are giving satisfactory service and have the advantage of being low in first cost. The C. & O. bearing plate is 1 in. thick, which is heavier than most railroads use. However, the 1-in. plate was adopted because of trouble with thinner plates. Most of the trouble from this type of anchorage is caused by too small and too light bearing plates, or bearing plates spaced too far apart, overloading the concrete and causing it to crack and spall.

Bolts $\frac{3}{4}$ in. in diameter are believed

to be a little too light for anchor bolts. A $\frac{7}{8}$ -in. bolt, we believe, is more satisfactory and the C. & O. tentative design calls for 1-in. bolts. However, for more severe conditions, as on curves or higher speed tracks, anchorage similar to that adopted by the Canadian National should prove more satisfactory, owing to its sturdiness and flexibility, with a corresponding increase in initial cost.

Although several railroads imbed structural steel shapes, castings, bearing plates, etc., in concrete walls, it is believed to be more practicable to rest such steelwork directly on the concrete than it is to imbed all or any part of it in the concrete, particularly on outside construction. It is difficult to pour concrete so it will engage wide surfaces like flanges of steel beams without slight voids adjacent to the steel. Also, concrete may shrink sufficiently to leave voids adjacent to the steel. Such voids on outside construction tend to collect moisture that, with freezing and thawing, disintegrates the concrete. Also, as there is no flexibility in concrete, any steelwork encased must have sufficient strength, rigidity and anchorage to withstand the loads and thrusts without movement; otherwise, adjacent concrete is liable to be damaged. Also, in embedding structural steel in concrete, the concrete is divided into two sections, thus weakening the concrete. If steel is solidly embedded in concrete, it should be so placed and anchored and the concrete so reinforced that the resulting combination will take all loads and thrusts without movement. It is noted, however, that two railroads encase short rails in their pit wall concrete, with the base up, and weld the running rails to the bases of these short inverted rails, and report this construction as being satisfactory.

To secure rail direct to wide-flange steel beams on coal trestles, the Michigan Central uses a two-piece clip, consisting of a 5-in. by $\frac{1}{2}$ -in. by 6-in. steel plate clip secured to the wide-flange beam with two $\frac{3}{4}$ -in. by $3\frac{1}{4}$ -in. bolts, double nutted. A 3-in. by $\frac{5}{16}$ -in. by 6-in. filler plate is placed under the outer 3 in. of the $\frac{1}{2}$ -in. clip plate as a filler approximately the height of the rail flange, with two bolt holes matched with the upper clip plate. The clip plate is bent



Channel-Shaped Castings and Bolt Assembly Used to Fasten Rails to Pit Walls

slightly to conform with the slope of the rail flange and the corner engaging the rail is ground to fit the fillet of the rail. The clips are spaced on about 18 in. centers and are staggered $1\frac{1}{2}$ in. to avoid holes being in line in the wide-flange girder.

The Elgin, Joliet & Eastern uses a similar 2-bolt clip, consisting of a 5-in. by $\frac{1}{2}$ -in. by $6\frac{1}{2}$ -in. rail clip with a $2\frac{3}{4}$ -in. by $\frac{1}{2}$ -in. by $6\frac{1}{2}$ -in. filler, using two $\frac{7}{8}$ -in. bolts. However, the Elgin, Joliet & Eastern does not make a bend in the $\frac{1}{2}$ -in. clip plate to fit the slope of the rail, using clip bolts to pull the clip plate into tight contact with the rail.

When rail clips, hook bolts or any

other type of fastenings are used to secure the rail to steel or concrete, cognizance must be taken of the fact that the steel or concrete to which rail is secured must be securely anchored against spreading. Any ties, rods or diaphragms placed to keep steel girders from spreading should either engage the top flange of the girder or the web of the girder as close as possible to the top flange. No standard spacing for such tie rods or diaphragms can be given as the spacing depends upon the lateral stability of the supporting beams; i.e., the lighter the supporting beams, the closer must be the spacing of the tie rods or diaphragms.

On timber coal trestles, or similar construction, where the speed is slow and the track tangent, a full length tie every four feet is considered adequate to keep the rail to gage, the intermediate ties supporting the rail being tie blocks of approximately the same length as the width of the timber stringers. As walks are usually required on this type of construction, the long tie at four-foot centers furnishes a good support for the walks and railing.

On cinder pits, the anchorage on the masonry wall side may be the same type as is used on engine pit walls. However, owing to severe rust action, they should be heavier to insure longer life, and spare parts should be kept readily available. The New York Central uses a channel-shaped cast iron casting, with rail support and fastening cast integral with it. This casting is made up in approximately five-foot sections and fits over the top of the concrete wall for the full length of the pit, being seated in grout with the channel legs down. In the New York Central design, the legs of the channel engaging the concrete wall automatically anchor the casting on the wall, and rail

chairs cast on top of and integral with the channel casting are designed to hold the bolt heads for the rail clip bolts in slots. These castings anchor the rail satisfactorily and, in addition, protect the top of the concrete wall from severe heat and disintegration.

Rail not supported on the masonry pit wall is usually supported by a wide-flange beam, using heavy rail clip fastenings. The beam supporting the rail is usually supported on high-ribbed type, heavy cast iron or cast steel castings. It is not advisable to use long spans between castings, owing to the tendency of the long and deeper girders to warp and deflect as the result of excessive heat. No adequate protection is known to be available for protecting castings, rail fastenings, etc., from excessive heat and corrosion that does not involve considerable maintenance. Rail supports and fastenings should be overly designed and spare parts kept readily available.

The Milwaukee has recently designed a 4-ft. by 4-ft. by 72-ft. reinforced concrete cinder pit having walls 12 in. thick. Rails are supported on 8-in. by 10-in. rail plates at 20-in. centers, with a cushion plate of second-hand grain belting $\frac{3}{8}$ in. thick between the concrete and the rail plate. The outside rail flange is anchored by $\frac{7}{8}$ -in. by 16-in. anchor bolts and standard rail clips. The inside of the rail plate is anchored to the concrete by two $\frac{3}{4}$ -in. by 14-in. anchor bolts at $5\frac{1}{2}$ -in. centers. Rail clips engage the inside bottom flange of the rail at 20-in. centers but are not secured by anchor bolts. A 5-in. by 4-in. by $\frac{1}{2}$ -in. continuous angle with the 4-in. leg down is placed on top of the rail clips, engaging the inside flange of the rail which is anchored in place with $\frac{7}{8}$ -in. by $2\frac{3}{4}$ -in. stud bolts at 20-in. centers, which anchor both the angle

iron and the inside rail clips by being tapped into the rail plate. The angle iron protects the top edge of the concrete wall as well as the track fastening and rail. The space between the angle iron and the base of the rail is filled with knife-grade asbestos putty.

Care should be taken in using beams for short pit spans that are designed for bending only, as such beams with small end bearings are subject to failure of the webs over the bearings. If beams for these short spans are not designed carefully to take care of excess stress in the webs, due to the small bearing and the wheel loading and pounding of the wheels caused by the change in track construction and lack of cushioning, end stiffeners should be placed over the bearings.

The use of creosoted tie blocks, 8-in. by 10-in. by 2-ft. 6-in., spaced 18-in. to 20-in. centers and imbedded in concrete, is common practice in tunnels and on station tracks, wash racks and concrete roadbed, using standard track fastenings to support the rail. The Pennsylvania recently built a wash rack at its Harrisburg, Pa., engine terminal, using this type of construction. This type of rail support, using shorter blocks, is also used to some extent to support rail on engine pits.

Installations of creosoted tie blocks are particularly well suited for station tracks where cleanliness and drainage are major considerations. Such tie blocks have been in service for many years in terminals in Chicago, New York and Indianapolis, Ind., and have more recently been installed in the Dayton, Ohio, station. Drainage can be either to the center of the track, as at most terminals and tunnels, or to the side, as on the Pennsylvania wash rack. On the latter, the tie blocks are bolted down with two $\frac{3}{4}$ -in. bolts, while on the station tracks at Dayton, and other installations,

tie blocks are not bolted down, depending upon the concrete encasement to hold them in place. At the Chicago and Dayton terminals the imbedded ties are reported as remaining tight and not requiring additional anchorage. When it becomes necessary to remove a tie block, it is split into pieces, replaced with a slightly smaller one and concrete grout poured around it. When tie blocks are anchored with bolts or dowels, it is necessary to remove the rail before a block can be renewed. This feature adds materially to the cost and inconvenience in maintaining such tracks.

Turntables

Difficulty has been encountered in maintaining the heavy circle rail of three-point bearing turntables. At such locations the concrete under the circle rail must be the best obtainable and it should be leveled perfectly and have a solid foundation with good drainage of the top concrete surface as well as of the foundation, unless set on rock or piling; otherwise, the circle rail will not perform satisfactorily, regardless of rail or fastenings.

One railroad reports both center-bearing and circle-wall foundations resting on solid clay without adequate drainage being installed. The surrounding water level, being somewhat higher than the turntable foundations, softened the clay foundation material sufficiently to start the masonry pumping water, carrying some clay away from the foundations when the load was applied to the turntable. It was necessary to pump grout under the foundations to push out the mud and water and seal any voids, and then to install adequate drainage.

At the Pennsylvania's terminal at Harrisburg, the circle rail for the 125-ft. turntable is supported on cast steel chairs 10½ in. high, spaced

quite close together, and the concrete was finished to exact elevation. To obtain an accurate bearing for such a location, it is usually necessary to set the screed strips a little high and then grind down the concrete to the required elevation. Accuracy to $1/32$ in. should be required. The flat concrete surface should be surface waterproofed and should pitch sharply away from the bearings to assure good drainage, and the rail supports should be such that water, dirt, cinders, etc., will not collect against the rail supports. The Pennsylvania's design at Harrisburg has a trough in the concrete outside the circle rail, adjacent to the pit wall, to collect this drainage. Good drainage could be obtained by providing a good slope to the concrete back of the circle rail, with sufficient openings between the supports for drainage to pass through. The cast steel chair rail support above mentioned is a change from the usual support of the circle rail and may prove to be a step in the right direction. It has proved satisfactory since its installation in 1938. They have the advantage that when the concrete supporting them requires repair, such repairs can be made more readily than if the rail is supported on large flat bearing plates.

The pit rail for a 115-ft. New York Central turntable installed at Toledo, Ohio, in 1941, is supported on 14-in. by $1\frac{1}{4}$ -in. by 16-in. steel plates with 16-in. by $1\frac{1}{4}$ -in. by 20-in. plates at the rail joints. The circle rail is of 130-lb. RE section and the bearing plates are spaced at 2-ft. $4\frac{1}{4}$ -in. centers. Anchor bolts are $1\frac{1}{4}$ -in. by 19 in., securing special heavy malleable iron rail clamps $1\frac{7}{8}$ in. thick at the heel and $1\text{-}1/16$ in. thick at the toe.

Note should also be taken that the Canadian National uses its type of rail chair to support the circle rail

on its turntables and finds it to be entirely satisfactory. Here again the flexibility of this type of rail support adds to its value.

Fastening Circle Rails

Extreme accuracy is required in the setting of anchor bolts for turntable circle rails and allowance must be made for the expansion and contraction of the rail. There is the possibility that, with proper setting of the anchors to take care of expansion and contraction, the circle rail could be welded at the joints, resulting in smoother operation of the turntable.

The Chicago & North Western has four 110-ft. twin span turntables where the joints in the circle rails are welded. These tables have been in service since late 1929. The circle rails are of 130-lb. section. In 1938, due to failure of many of the rails at one of these tables, new rails were installed and the joints were welded at time of installation. Shortly thereafter, the original rails at the other locations were welded.

The essential features of this work were:

- (1) The gas welding process was used.
- (2) Railway company track welders, under the direction of supervisors of one of the gas welding supply companies, did the welding.
- (3) The expansion and contraction of the circle rail was disregarded.
- (4) The existing anchorage of the circle rail was overhauled and carefully adjusted.
- (5) The rails were brought to exact surface and alignment as the work progressed and the anchorage was tightened.
- (6) All possible attention was

given to preheating and controlled cooling after completion of each joint weld.

- (7) The use of the turntable was curtailed as much as possible to facilitate the work.

The American Bridge Company takes care of lateral adjustment of the circle rail by using eccentric adjustable lock rail clips. At the New York Central turntable at Toledo, Ohio, this adjustment is taken care of by steel wedges.

On a 102-ft. turntable, built in 1936, a 175-lb. crane rail was used for the circle rail, supported on 15-in. by 1-in. by 4-ft. 7-in. closely-spaced bearing plates, each having four 1 $\frac{1}{8}$ -in. by 21-in. anchor bolts with adjustable lock rail clips. It is believed that shorter bearing plates or rail chairs, properly spaced, are preferable to these large bearing plates, as it is difficult to get an even bearing under large plates and they tend to block the drainage back of the circle rail. Also, any repairs required to concrete under the bearing are difficult to detect and repair.

All of the railroads contacted use on their turntables ties similar to those used on open-deck bridges. A few railroads report satisfactory welding of rail joints on turntables to give smoother riding, and a few use special proprietary fastenings to prevent shifting of the rail. To prevent pounding at the ends of the table, some place hardwood ties or wider ties for four ties at each end. The usual practice for supporting the ends of rails on the pit wall is by means of a heavy wide-flanged steel circle beam anchored on top of the pit wall, to which track rails are secured with two-bolt rail clips. These rails should not be connected directly to the pit girder by bolting or welding as the expansion of the rail on the approaches will either break the connection or shift

the rim girder. A liberal installation of anti-creepers is necessary on the approach tracks to reduce creeping of rail to a minimum.

Rubber tie plate shims have been developed by rubber manufacturers for the circle rail and for the running rail on turntables. This is one of the newer developments that would seem to have much merit.

At least two railroads report the use of angle bars at the ends of rails to help retard damage from pounding. Several railroads report that no special precautions are taken to eliminate pounding at the ends of the turntable, except to attempt to maintain a $\frac{1}{2}$ -in. gap and level surface of the rail ends.

Tracks approaching a turntable should be tangent well beyond the length of the longest locomotive and tender, otherwise trouble will be experienced in operating the table.

Anchoring Rail on Bridges To Resist Longitudinal Motion

In considering the longitudinal motion of rails on bridges due to contraction and expansion and creeping, the most important consideration is to retard the rails on the approaches from exerting movement on the bridge. This can best be accomplished by bunching rail anchors on the embankment.

In replies to our questionnaire, we find that the railroads differ on this subject. The Canadian Pacific, Pennsylvania, New York Central, Great Northern, Baltimore & Ohio, Chesapeake & Ohio, and Chicago, Milwaukee, St. Paul & Pacific do not anchor rail on bridges. The Michigan Central uses special anchors. The Rock Island places special expansion devices on exceedingly long fixed spans. The Northern Pacific anchors at the fixed ends of spans and bunches

the anchors on the roadbed adjacent to the bridge. The Illinois Central reports the use of both switch points and expansion joints. The Southern Pacific reports one bridge, 4,460 ft. long, on which the rail is laid continuous. However, on ordinary spans over 400 ft. long, this road provides expansion rails because of the concentration of the expansion at one

or more of the many governing limitations, rail may be fastened directly to the steel or concrete deck by means of heavy malleable iron rail plates and clips. In case rails are anchored directly to concrete, careful consideration should be given to obtaining the best concrete available, suitably waterproofed, in order that the life of the fastening will not be limited by



**Spring Clips
Are Used to An-
chor Rails on
Many Bridges**

end. The Elgin, Joliet & Eastern installs expansion joints at each end of long structures. The Chicago & North Western provides switch points at the expansion ends of long spans; for shorter spans it finds compression fastenings very effective.

Conclusions

The fastenings on bridges, pits and turntables are, to a large extent, designed to conform to, or are an adaptation of, the general track structure. Where headroom and other requirements allow, ballast-deck structures are in favor, owing to the fact that such decks provide a continuity of the ballast section, permitting track forces to take care of gage, line and surface.

Where ballast deck construction cannot be recommended, due to one

the life of the concrete.

For open-deck steel and timber structures, the preframed and pre-bored time-tested creosoted timber tie and standard track fastening are still in universal use to anchor the rail to the structure. Ties of quality, even when preframed, prebored and treated, have tendencies of weakness. They are subject to checking and splitting, fire damage and damage due to derailment. However, no suitable substitute has been developed to date.

Consideration should be given to the welding of rail joints on open-deck bridges to give smoother riding track, reducing impact. Also, for special installations, a tie plate having a rubber bearing for the rail is worthy of study for the same reason.

Many special types of rail fastenings are in use on pits. Substantial steel bearing plates at 18-in. to 20-in.

TABLE I

Size, Spacing, Framing and Kind of Bridge Ties For Open-Deck Steel and Timber Bridges

Rail-road	Open-Deck Steel Bridges					Timber Trestles		
	Stringers 6'-6" Centers	Stringers 7'-0" Centers	Stringers 7'-6" Centers	Stringers 8'-0" Centers	Framing	Size and Spacing of Ties	Framing	Kind of Wood
B&O	8x10 @ 14" Ctrs.	8x11 @ 14" Ctrs.	8x12 @ 14" Ctrs.	8x13 @ 14" Ctrs.	Dapped	8x8 @ 14" Ctrs	Not Dapped	White Oak
C&O	8x10 @ 12" Ctrs	8x10 @ 10" Ctrs	8x11 @ 12" Ctrs	8x12 @ 12" Ctrs	Dapped	8x8 @ 12" Ctrs	Not Dapped	Y.P. Oak
* CMSTP			8x12 @ 16" Ctrs	8x12 @ 16" Ctrs	Not Dapped	8x8 @ 16" Ctrs	Not Dapped	Fir
CGW	12" Ctrs	12" Ctrs	12" Ctrs	12" Ctrs	Not Dapped	8x8 @ 14" Ctrs	Not Dapped	Fir
CRIP	8x10 @ 12" Ctrs	8x10 @ 12" Ctrs	8x10 @ 12" Ctrs	8x12 @ 12" Ctrs	Dapped	6x8 @ 13" Ctrs	Not Dapped	S.Y.P.
C&NW	8x10 @ 13" Ctrs	8x10 @ 13" Ctrs	8x12 @ 13" Ctrs	8x12 @ 13" Ctrs	Not Dapped	8x8 @ 13" Ctrs	Not Dapped	Fir
D&H	9x11 @ 15" Ctrs	9x11 @ 15" Ctrs	9x14 @ 15" Ctrs	9x14 @ 15" Ctrs	Dapped	9x9 @ 15" Ctrs	Not Dapped	Oak Y.P.
DT&I	8x8 @ 14" Ctrs	8x10 @ 14" Ctrs	8x10 @ 14" Ctrs	None	Dapped	8x8 @ 14" Ctrs	Dapped	Oak
EI&E	8x8 @ 12" Ctrs	8x10 @ 12" Ctrs	8x10 @ 12" Ctrs	10x12 @ 14" Ctrs	Not Dapped	8x8 @ 12" Ctrs	Not Dapped	White Oak
ERIE	8x10 @ 12" Ctrs		8x12 @ 12" Ctrs	8x14 @ 12" Ctrs	Dapped	8x8 @ 12" Ctrs		L.L.Y.P
GN			8x12 @ 14" Ctrs		Not Dapped	8x8 @ 14" Ctrs	Not Dapped	Fir
** IC	8x8 @ 12" Ctrs	8x8 @ 12" Ctrs	8x10 @ 12" Ctrs	8x10 @ 12" Ctrs	Not Dapped	6x8 @ 14" Ctrs	Not Dapped	S.Y.P.
*** MC	8x8 @ 12" Ctrs	8x10 @ 12" Ctrs	8x10 @ 12" Ctrs	8x12 @ 12" Ctrs	Dapped	8x8 @ 14" Ctrs	Dapped	Y.P.
MKT	Varies	Varies	Varies	Varies	Dapped	8x8 @ 16" Ctrs	Not Dapped	Fir
*** NYC	8x8 @ 12" Ctrs	8x10 @ 12" Ctrs	8x10 @ 12" Ctrs	8x12 @ 12" Ctrs	Dapped	8x8 @ 14" Ctrs	Not Dapped	S.Y.P.
NP	9x11 @ 14" Ctrs	9x11 @ 14" Ctrs	10x13 @ 15" Ctrs	10x13 @ 15" Ctrs	Dapped	8x8 @ 15" Ctrs	Not Dapped	
PRR	10x9 @ 16" Ctrs	10x9½ @ 16" Ctrs	10x10 @ 16" Ctrs	10x10½ @ 16" Ctrs	Dapped	10x8 @ 16" Ctrs	Dapped	Oak Usually
**** SP	10x10 @ 14" Ctrs	10x10 @ 14" Ctrs	10x12 @ 14" Ctrs	10x12 @ 14" Ctrs	Dapped		Not Dapped	Pine & Fir

* CMSTP&P reports the use of untreated fir ties spaced 16" center to center. This spacing has been in effect for more than 3 years and to date has proven satisfactory.

** Key ties 2" deeper with 2" dap placed every sixth tie.

*** 3¾" Brine Blocks between each tie.

**** The SP report the use of chromated zinc treatment for ties on open-deck bridges because of its fire-resisting qualities.

TABLE II
Rail Fastenings on Bridges and Pits

Railroad & Safe Speed For Fast- enings	Rail Fastenings—Main Line Bridges				Fastenings to Steel on Pits	Fastenings to Concrete on Pits	
	Size of Tie Plate and Weight of Rail	Hold Down Spike per Rail		Rail Spike per Rail			
		Tang- ent	Curve	Tang- ent	Curve		
MC		2 Screw	2 Screw	2 Cut	2 Cut	W. F. Beam 2 Bolt Clips	Creo. Tie Blocks
B&O NR	7¾x14-131# 7¾x12-112#	2 Cut	2 Cut	2 cut to 1°	3 cut more 1°	Clips or Hook Bolts	Plates & Clips @ 2' Ctrs.
C&O NR	Standard A.R.E.A.	None	None	2 Elastic	2 Elastic	Rail Clips	Plates & Clips @ 18" Ctrs.
CMStP&P 100 MPH	7½x12-131# 7½x11-112#	2 Cut	2 Cut	2 Cut to 2°	3 Cut 2°-6° 4 Cut over 6°	Clips or Dir. Bolting	Creo. Tie Blocks @ 2' Ctrs.
CGW NR		None	None	2 Cut	3 Cut	Clips or Hook Bolts	Inverted Rail Welded
CRIP NR	7½x11-112# 7½x10½-110#	None	None	2 Cut	Over 4° Spec'l	Adj. Clips @ 3' Ctrs.	Adj. Clips @ 3' Ctrs.
C&NW NR	7½x11-112# 7x10½-110#	None	2 Cut	2 Cut	2 Cut	Rail Clips or Hook Bolts	Cast Chair and Clips
CP NR	7x12-130# 7x10½-100#	None	None	2 Cut	3 Cut		⅞ Bolts & Ecc. Washers
*D&H NR	8x13½-131# 7½x12-112#	2 Screw	2 Screw	2 Cut	3 Cut	Rail Clips	Steel Grillage & Clips
DT&I 60 MPH	7½x11-112#	None	None	2 Cut	4 Cut	Clips or ⅞ Hook Bolts	Plates & Clips @ 18" Ctrs.
EJE 45 MPH	8x12-131# 8x11-112#	None	None	2 Cut	2 Cut	2 Bolt Clips @ 1'-6" Ctrs.	⅞ Bolts & Special Clips
ERIE 70 MPH		2 Screw	2 Screw	2 Cut	2 Cut	⅞ Hook Bolt @ 18" Alt.Sp.	To Suit Conditions
GN				Cut	Cut	Clips or Hook Bolts	Bearing Plates & Rail Clips
IC NR	7¾x11-112# 7½x10½-90#	None	2 Cut over 2°	2 Cut	2 Cut	Hook Bolts	Plates, Clips, ¾ Bolts @ 2'
MKT NR		None	None	2 Cut	2 Cut	Varies	Creo. Tie Blocks
NYC 80 MPH	7½x13-127# 7½x11-105#	2 Cut	2 Cut	2 Cut	2 Cut	Rail Clips	Plates & Clips
NP 70 MPH		None	None	2 Cut	Cut 3 or 4	Varies	Steel H. Beam Direct Bolted
PRR		Cut	Cut	Cut	Cut	Varies	To suit conditions
SP NR	Standard A.R.E.A.	None	None	2 Cut Tang. to 3°	3 Cut 2°-6° 4 Cut over 6°	None in use	Inverted Rail direct bolted @ 30" Ctrs.

NR = Track fastenings on bridges safe for any speed that rail and other track conditions will permit.

* = Also use proprietary type fastenings to large extent.

centers, with heavy steel or malleable iron rail clips and $\frac{7}{8}$ -in. or 1-in. anchor bolts will prove satisfactory. On cinder pits, fastenings should be protected from excess heat and rust action.

Creosoted tie blocks encased in concrete, using standard tie plates and track spike fastenings, are used extensively in tunnels, wash racks, station tracks and, to some extent, on concrete pit walls.

One suitable design for fastening rails to all structures is a goal well worth striving for, providing such a design meets economical necessities. Your committee did not reach this goal, but trust that the search it has made will assist others in quest of it.

DISCUSSION

President Dove: If you have been following the reading of this report in your magazine, it is evident to you that the committee has gone into this subject very thoroughly. I was fortunate in seeing a copy of the questionnaire which was sent out by the committee and the replies which were received. They went into great detail in developing the information contained in this report.

All of us have experienced more or less difficulty in maintaining tracks properly at bridges, pits and turntables, and it is obvious that much of this difficulty could be eliminated by the use of proper fastenings. It was this thought that prompted the Subjects committee to select this subject. The meeting is now open for discussion.

H. M. Church (C. & O.): I call attention to that part of the report making reference to the heavy tie

plates and fastenings used by the C. & O. This is not our standard plan, but is rather in the experimental stage. In view of the necessity for conserving steel, we have recently put in five pits where we have used short ties embedded in concrete.

Now, to eliminate bolt anchorages entirely, and so that no special steel would be required, we have put these ties at a slight angle to the longitudinal axis of the pit walls, so they intersect the face of the wall at an angle of 1 in 12. By this method, you can either use a standard tie plate and 2 spikes, or no tie plates. This also conserves in the use of 8-in. by 16-in. structural timbers, which are difficult to secure under existing restricting orders. This is one way to conserve scarce materials in the interest of the war and the maintenance of an essential civilian economy.

Renewing Ties on Bridges

R. E. Caudle (M. P.): This committee is to be complimented on the comprehensive report it has compiled. It covers a multitude of problems that have confronted us from time to time, and probably will continue to confront us in the future.

There are one or two items in the report I want to discuss. Reference is made to repairs to the ties on open-deck trestles. It is a very good idea to keep the new ties and the old ties separated. In other words, if you are making a certain percentage of renewals, I find that it is much better to use new ties on one end of the bridge to such extent that sufficient old ties may be recovered to spot in

along with the old ties that are left on the remainder of the bridge.

The reason for this is that if a new tie is installed among the old ties, it is usually necessary to adze the top of the new tie down to keep the rail from swinging over the old ties on each side. If this is not done, the result is a rough-riding bridge deck. The new tie will always be a little high and will leave the ties on each side swinging, which will be noticeable at high speed over the bridge.

It has been our practice for a number of years to use all the new ties on one end of the bridge, and to recover enough old ties to do the spotting in among the remaining old ties.

Another point that I wish to discuss is the anchoring of the rail on open-deck trestles. On some of our territory, the rails run in opposite directions, resulting in tight gage and the bridges getting badly out of line. We have abandoned the practice of anchoring rails on open-deck trestles, except in isolated locations.

When we abandoned the practice of anchoring the rail to the deck ties, we increased the number of anchors in the track on each side of the trestle or bridge, which largely overcame the trouble with running rail. If we cannot find any better place to anchor the track than to a bridge deck, we are in quite a bad way.

G. S. Crites (B. & O.): I trust that the younger members paid particular attention to Mr. Caudle's remarks about spotting in ties. I suppose many railroads have treated Oregon fir or Douglas fir ties which were put in 15 or 20 years ago, and have since gone to hardwood treated ties. If you en-

deavor to spot hardwood treated ties, or even very firm Southern pine ties, in with the older ties, there is a likelihood of the new tie breaking as the result of pounding or impact. This is something that must be guarded against, and Mr. Caudle's practice of running the new ties out-of-face, and of taking the old ties out and reusing them among their kindred ties, is a practice which just must be followed.

Tight Gage

L. D. Garis (C. & N. W.): The narrowing of the gage of the track has been mentioned. I asked one of our track experts if there is anything dangerous about $\frac{1}{4}$ -in. narrow gage.

"Well," he said, "in the past we have laid a lot of new track $\frac{1}{8}$ -in. tight, and after trains have run over it for a while, it becomes another $\frac{1}{8}$ -in. tight as the result of the tie plates cutting into the ties. This gives us $\frac{1}{4}$ -in. narrow gage, and produces about the best riding track we have."

This was interesting information to me, but he told me that, in spite of the good riding qualities produced, the practice of laying rail tight had been discontinued.

Along the line of being careful about what one says, I think one should be doubly careful about what he writes, and when somebody writes, "Once it is installed, it is apparently permanent and requires no maintenance," I would suggest to the author that he start to work on perpetual motion.

The ingenuity that has been used in devising different types of rail fastenings is certainly interesting. There are many types beside those covered in this report. I ran across

one on a cinder pit which was made entirely of steel, and probably would be frowned upon at this time because of that. But none of this steel involved factory-manufactured parts. The supervisor who made this installation cut rails to a length equal to the width of the cinder pit concrete wall and embedded them in the concrete with the head down. He then welded a tie plate to the base of each length of inverted rail and cut off track spikes and welded them to the tie plate to hold the track to gage. This installation, at Madison, Wis., has been in service for 10 years. At the time I saw it, it had given quite a bit of punishment to the buckets used to take the cinders out of the pit, but the rail fastenings were in very good condition, except for corrosion and abrasion.

Armstrong Chinn (Alton): Mr. Garis commented on tight gages. I have had some experience on my railroad with this and maybe have the answer. For many years before I came to the Alton, it was the practice to lay all new rail $\frac{1}{4}$ in. tight. It is a fact that the track rode well and sounded well under moving equipment. It had a steady, tight feel, and the sound was nice, and that was what the former president liked. However, after we got enough new rail laid that way, we commenced to get complaints from the mechanical department that the wheels on our passenger equipment were developing false flanges, especially the high-speed equipment. After studying the matter considerably, we came to the conclusion that the tight gage was to blame and abandoned it. Since the gage has been restored to standard, we have had no fur-

ther false flange trouble. For this reason, I would advocate standard gage where it can be maintained.

Waterproofing Concrete

I was quite interested in the comments made about waterproofing concrete. If we could find a satisfactory way of waterproofing concrete, we might permit the cement manufacturers to re-adopt their original slogan, "Concrete for Permanence." The reason they had to give up this slogan was that after concrete had been in service long enough to show what it would do, it was found that it weathered even worse than stone or brick, and was not permanent. But I do believe that if we could find a way to waterproof it thoroughly, it would be about as near permanent as anything we could find.

The only other damage that occurs to concrete is from mechanical wear, and I believe the bridge engineers know how to make their designs to avoid that. I hope that somebody not only discovers a way to waterproof new concrete so that it will stay waterproofed, but will also find a way to waterproof old concrete satisfactorily so as to stop further deterioration. There are, of course, many products on the market for waterproofing concrete. Some give satisfactory results over a good many years, but I have not found or heard of any that will waterproof concrete for as long as it would last if it would only stay waterproofed. I am glad to see this question brought out in the open, because it will start people thinking and maybe we will eventually get the right answer.

At another place in the report, mention is made of a method of

supporting the ends of the rails in the tracks approaching turntables, employing wide-flanged beams that are placed on top of the turntable circle wall. I have had some very satisfactory results supporting the ends of these rails on heavy timbers placed on top of the circle wall, and in view of the difficulty, if not impossibility, of getting steel beams for this purpose at the present time, I think consideration, at least, should be given to the use of timbers.

End Support at Turntables

A. M. Knowles (Erie): I want to touch on this same subject of the support of rails at the ends of tables. I have just served as the chairman of a sub-committee of Committee 15 of the American Railway Engineering Association, revising its specifications for turntables. On that committee were representatives from, I think, about 15 railroads, and this particular point was very controversial. Some, to their satisfaction, had used beams on the circle wall and on the ends of the table, and others had not had very satisfactory results. The conclusion of the committee was that better results would generally be obtained if timbers were used on the circle wall and on the ends of the table, with adequate plates — not standard tie plates, but larger and thicker plates — under the rails on the timbers to prevent mashing of the timbers.

It seems almost impossible to maintain the proper level of the top of the rail on the approaches to and on the ends of the table. The ties or I-beams deteriorate and crush under the hammer blows

of locomotive wheels going over the gap between the rail. This gap must be three-quarters of an inch or more, and it is likely to be more rather than less. I have seen it as much as four to six inches. It was the conclusion of the committee that timber construction was more satisfactory in the long run than I-beams. The I-beams provide a more solid support, but it is so rigid that it just hammers to pieces, deteriorates from corrosion, and the maintenance is greater than on timber.

President Dove: The damage is greater to the rail too, is it not?

Mr. Knowles: No, the beams themselves are damaged, the webs crush, and they are hammered down so that they are no longer serviceable. It is very difficult to repair and replace them and you must get new beams. The timber is more resilient than the steel beam and has a beneficial effect on the end of the table, the circle rail and the end trucks. On those tables where the truck wheels are equipped with roller bearings, the bearings suffer severely from the heavy impact of the locomotive going on the table. The timbers on the ends of the table provide a little cushioning there, easing up the whole end construction.

Mr. Church: I would like to supplement Mr. Knowles' remarks by saying that we have used I-beams on turntable circle walls and have had continuous trouble with them. We are looking for some better design to overcome this.

Mr. Crites: I believe there are two problems involved. One is the problem of the three-point turntable, or continuous table, where you can adjust the level of the

rails approaching the table to those on the table and keep them at the same elevation; and the other is the problem of the cantilever type, or center-suspension table, which is apt to be loaded to a capacity beyond that for which it was designed, with the result that you have to take care of the added deflection. In cases where engines must run across such tables, there is usually a bounce.

It would appear that for the three-point supported table, the more permanent construction of concrete may serve, but that for the cantilever table, adjusted for tilt, the wood coping is undoubtedly the only answer. Of course, the wood coping has to be fully plated.

Mr. Knowles: My impression is that I-beams at the ends of tables were introduced about the time the continuous turntables were put out by the two steel fabricating companies which build most of this type of table. I think these are the tables where most of the trouble has occurred. It was the report of my A.R.E.A. committee that the railroads having these tables in service, with I-beams on the ends and on the circle walls, were the ones experiencing the most trouble.

Mr. Church: I can support that further by saying that it is at locations where we have the three-point turntable with I-beam construction that we are having the most trouble. Heretofore, we used timber on the coping for the center-supported table, with better results.

A. L. McCloy (P. M.): We used to have considerable trouble with our tables. When they were put in,

a plain oak timber alone was used, but a few years ago I installed pre-framed creosoted fir, and then put a one-inch steel plate, about 16 in. long, under each rail as a rail support; that overcame the difficulty. But the main difficulty was with our fastenings on the ends, of the turntable. The end ties on the table have a tendency to flip up when you strike the table if you do not have the proper fastenings.

Three years ago I put in all new ties on a table. Over the end tie, I put a steel plate, one inch thick, which reaches back and catches the second tie. This plate is about 24 in. wide and runs clear across the table to a point 8 in. outside the running rail on each side. The running rail is bolted to the plate and the plate is drilled and spiked to the ties. Then I bolted a guard rail on the inside at both ends of the running rail to prevent derailment. As a result, we have not had a derailment since, and the fastenings are giving good satisfaction.

Mr. Knowles: I would like to add another word on that point. For many years we have used that type of construction. We use a 24-in. by $\frac{3}{4}$ -in. plate, 8 ft. long, with a guard rail attached to it. On the outside of the rail we provide what we call an easer rail; that is, a rail to reinforce the main rail. The head of the easer rail is right up against the head of the running rail. The bottom flange is cut off to allow that. This arrangement provides a very substantial rail to take the hammer blows of locomotives.

We have had this construction primarily on our center-bearing tables. On the three-point-bearing tables, we have not used it so much, but where used, we have found it very satisfactory. It over-

comes the trouble spoken of by Mr. McCloy, of the ties becoming loose and moving at the ends, and it provides ample bearing area over the ties for the rail to take all the shock. It is one of the most satisfactory details we have found for turntables.

Mr. Crites: It would be interesting to know what, if any, locking device the Erie uses when inner guard rails and easer rails are placed at the ends of turntables.

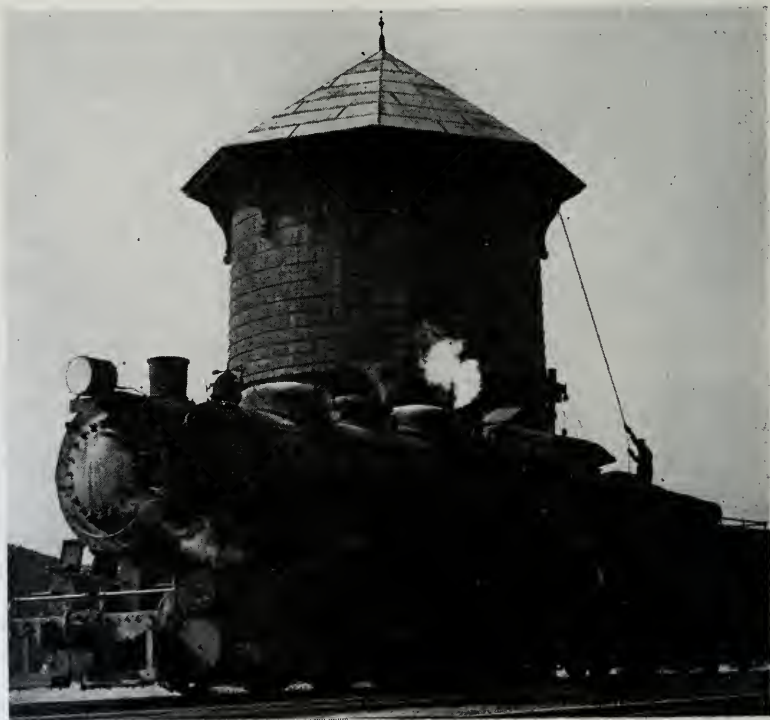
Mr. Knowles: We do not use locking devices where the tables are equipped with tractors. The tractors have brakes and hold the table satisfactorily to avoid derailments.

The guard rail, of course, has a flared end on it at the end of the table to allow for the entrance of the wheels in case the table is a little off center.

Mr. McCloy: We have no locking devices on any of our turntables. We depend on the brakes and the alinement of the table.

President Dove: Gentlemen, I think we have had a fine discussion of this very thorough report. I recommend that you reread it thoroughly.

I will now dismiss this committee with the thanks of the association for a fine piece of work.



The Material Situation As Seen By WPB*

By David P. Beach

Assistant Chief, Maintenance Equipment Section,
Transportation Branch, WPB, Washington, D.C.



David P. Beach

Everyone knows that adequate and efficient transportation is vital to the successful prosecution of the war, but the job right now is to see that the railroads function

properly and are maintained with a minimum amount of strategic materials. It is a job that is going to require ingenuity, resourcefulness and vision. The amount of critical materials set aside and available for purposes other than munitions and ordnance has been constantly shrinking with the speeding up of the war program, and now is so small as to become a matter of grave concern. Maintenance requirements must be provided first, with essential expansion or new work getting what is left.

The common problem is to maintain facilities on an absolute minimum basis in order to make available a portion of the critical materials for urgent expansion. Plans for expansion must be designed with only one object in view, and that is to meet the emergency

with the use of the least amount of critical materials. Ordinarily, the term "absolute minimum basis" does not need any amplification. Usually, this term is associated with cutting operating expenses to the bone, as in the depression years of the 1930's. Today, the railroads must handle an unprecedented volume of traffic, but the same yardstick must apply with reference to the use of materials, nearly all of which are now critical. Lumber requires an emergency rating of AA-2X for reasonable delivery. Bridge, structural and reinforcing steel cannot be procured without a rating comparable to army and navy ratings. Clay products are about the only non-critical materials; and in some sections of the country it is difficult to get reasonably prompt delivery on cement.

Instructions Not Enough

Of first importance in considering this problem of conserving materials is a full realization of the responsibility of every individual who has anything to do with the ordering or the use of materials. The successful results of the safety movement were accomplished by constant and energetic education in safe practices. The drive to conserve strategic materials for war purposes overshadows any drive in the history of

*First of a series of four addresses in a symposium on the material situation.

railroading. More vigorous action is required than simply putting out instructions. Everyone has the "must win the war" spirit, but leadership and co-ordinated efforts are essential to success. It is obvious that this job of saving precious material for guns, ships, tanks and ammunition must be done by those at home, and not in Washington. The functions of the Transportation Branch of the War Production Board are of a policing nature; not only to eliminate requests for material deemed non-essential to the war effort, but to assist railroads in obtaining vital materials. The wasteful and unwise use of critical materials should be dealt with as any other infraction of the rules.

To maintain the railroads on an absolute minimum basis under present conditions will require the exercise of good judgment in the use of materials. Every person using or ordering materials, from the mechanic to the storekeeper, will become material-minded in doing his part, if called upon, in the all-out war effort. Facilities which have become obsolete and are more or less worn out, and repair parts which are no longer obtainable, may be on programs for renewal. A special examination of such facilities by a qualified inspector may disclose means to keep them safely in service a few years more by patching.

The question to be answered in every such case where renewals seem necessary is, "Can they be made to last a while longer?" Such a procedure may not be the wisest expenditure of money under normal operations, but critical materials are priceless today.

Maintenance on an absolute min-

imum basis requires the use of all salvageable second-hand or fit materials. A careful "out-of-face" inspection should be made of each railroad and branch line and an inventory prepared of facilities that are unused or can be abandoned. The best results from such inspections can be obtained by well chosen material representatives who know how to search out every cubby hole and corner, not overlooking abandoned water lines or pipes.

To maintain on an absolute minimum basis, bridge programs must be prepared on the basis of repairing and patching structures where necessary to keep them in serviceable condition for the duration. Anything beyond this, such as the replacement of spans, should be made only after a rigid inspection and a thorough analysis of traffic conditions. To maintain existing structures under this policy will require closer and more frequent inspections and supervision to see that crucial defects are repaired immediately.

"As Usual" Methods Out

Many project applications received from various railroads of the country for bridge repairs and renewals were evidently prepared on the "as usual" basis and had to be returned for revision, cancellation or review for the purpose of eliminating critical materials. The railroads have responded with hearty co-operation in meeting this issue. Changes have been made in design to cut to a minimum the amount of steel to meet traffic requirements for the next few years, saving a considerable tonnage of steel. Temporary methods have

been employed to continue in service spans which ordinarily would be replaced. Reinforcing steel has been eliminated by redesigning concrete substructures to use mass concrete. Where steel must be used, efforts should be exhausted to use second-hand or scrap materials, or a canvass made of supply houses for materials in stock which can be adapted to the purpose. Any bridge design that requires specially rolled plates and shapes requires an emergency rating with an indefinite date of delivery.

Materials for railroad maintenance are handled under Order P-88, and the provisions in this order are intended to maintain facilities in sound working condition. Railroad purchasing agents make their requests for maintenance materials on Form 351. They must depend, however, upon main-

tenance forces for correct information as to their requirements.

The responsibility, therefore, rests with the maintenance forces to see that these requirements are on an absolute minimum basis; or there will be nothing left for essential new work.

President Dove: Mr. Beach, may I express the appreciation of our association and all present for your remarks. They give us a further insight into the critical material problem that faces us and will fortify us in our determination to contribute our part to the national war effort.

Mr Beach: Thank you.

... For the discussion which followed Mr. Beach's address and the other three following addresses in the symposium on "Materials," see page 142.



Troops of the 711th Engineer Battalion, Railway Operating, Building a 785-ft. Trestle on the Claiborne & Polk Military Railway

The Material Situation — As Seen By a Bridge Man

By J. B. Hunley

Engineer of Structures, New York Central System,
West of Buffalo, Chicago



J. B. Hunley

The situation as to the maintenance of our bridge structures becomes more critical with the freezing of each new item of critical structural material. In the beginning it was rather an

interesting game of matching wits with Washington. If some one thing was denied us, we could substitute something else, but that is becoming more difficult today. However, I am sure that we all now realize fully that we not only should, but must, work closely with those in Washington who are controlling materials, because, in the final analysis, we are all working toward just one goal—the goal of winning the war, and as speedily as possible.

Fortunately, bridge men are resourceful, that being one of their first qualifications, not only as a matter of necessity, since their work requires it, but also because it is something in which they take great pride. During the last decade, when bridge appropriations were low, this trait was developed to the highest degree. The men

who passed through this period are not only resourceful, but they are also tough.

Bridge Engineer Can Help

Today, money is far more plentiful than either labor or material. Under these conditions, the successful accomplishment of necessary structures work is finally going to depend upon these men and what little material is available—and it will require the closest co-operation between all concerned.

Since few, if any, new structures are now being built, or will be built for some time in the future, the bridge engineer can best spend his time giving every possible help to his maintenance men with their problems. He should see that questionable structures are inspected frequently and carefully, and, when possible, examine them personally, watching them under traffic. The stresses in light steel spans should be re-checked carefully to avoid repair or reinforcement if possible. He may find that he can “skate on thinner ice” than has been his practice, if there is no marked sign of distress and his experience and sixth sense of what is structurally right permit him to do so. If repairs are found necessary, he must devise methods which will involve

the use of the least new or second-hand materials, forgetting for the present that complete repairs, or a complete replacement, would be simpler and perhaps cheaper in the long run.

He should build up an ample stock of the less critical materials, which can be used in some way in emergencies, because emergencies may now occur more frequently and with less warning than heretofore. He should hold the use of scarce materials to an absolute minimum. If he must request some of these materials, his reasons therefor must be so sound that they will be allocated in full, in so far as possible. However, no matter how favorable the prospects for securing such materials may seem, it will be well for the bridge man to have in the back of his mind some other scheme which can be used if his request is refused.

To do these things, the bridge engineer will be forced to toss over-board many ideas regarding design and maintenance which his long experience has proven sound. He will have to do many things which he knows are uneconomical, doing work which will soon have to be done over. After considering his education complete, he must master a new technic—the art of substituting untried methods and materials; the taking of greater chances, and knowing just when to stop.

Field Forces Have Biggest Problem

But the men in the field—the supervisors, foremen and mechanics—are faced with problems which are equally, or even more troublesome than those of the bridge en-

gineer. No matter how expert or willing these men may be, they must work alone with the materials and tools which are supplied them. The longer I deal with such men, the more inclined I am to seek their advice rather than offer mine. But you have asked my advice, and I make the following suggestions to you.

Inspect your structures more carefully and more frequently, and if you find anything questionable about them, don't hesitate to consult your superior officers. They will not only want to help you, but will, particularly at this time, want to know everything that you can tell them about the condition of any structure which is being carried along on "hope and borrowed time."

Keep your power tools in good order, making "stitch-in-time" repairs to prevent the failure of any part, which, if it can be replaced at all, may take many weeks. Take special care of rubber hose, power cables, steel cables, manilla lines, etc. New equipment will not be available for some time, and with the evergrowing shortage of skilled men, and particularly of the younger men, present equipment becomes a necessity, rather than a mere time-saving convenience.

Save and hoard every usable thing, whether you have use for it immediately or not, and make frequent visits to your scrap yards or reclamation plants. If you get there first, you will find many things, including old rods which can be straightened and converted into machine or drift bolts. They can also be used for concrete reinforcement. Small diameter pipe can also be used for concrete reinforcement.

If there are any light spans that are no longer fit for use anywhere, cut them up and save the plates and angles. While the expense to do this may seem excessive, the material can be worked over for repairs, particularly of lateral systems. Sections may have to be spliced or welded, and the finished

four fewer chord or drift bolts to the panel than your standards call for.

Check the track surface on open-deck steel spans, and, if possible, reframe the ties so that the bearing between the rail and ties, and between the ties and steel is uniform and the track is in cross level.



When Repairing Timber Structures, They Should Be Opened Up With Gentle Hands to Avoid Damage to The Timber Left in Place

job may offend the eye, but, under the conditions, it will serve until something better can be had.

Other Suggestions

When heavy repairs to a timber structure become necessary, renew as much of the structure out-of-face as the material available will permit, saving the usable timbers removed for repairing other parts. Open up such a structure with gentle hands, as rough treatment may shorten by several years the life of any timber left in place. When your timber does not come pre-framed, re-check your field measurements before cutting it. As a further saving in steel, perhaps you may be permitted to use two or

See if the center line of the track coincides with the center of the span; it seldom does, and frequently it is so far off that one girder may carry from five to ten per cent excess load. On short spans, try to get the trackmen to remove or build up all battered joints near the center, or better yet, substitute continuous rail. With all the other things you have to do, this may seem to be asking too much, but if they are done, the stresses in the spans will be reduced materially, which, in a borderline case, may postpone replacement or strengthening, or make a speed restriction unnecessary.

You are probably all doing most of these things and many others besides, but we can't stop there.

We may expect the material situation to become still worse before it gets better, and we must keep asking ourselves—What will I do with this or that bridge if I can't get needed materials?—and have the answer ready when the time comes that something must be done with what is at hand.

We have almost learned to do without new structural steel, although a small amount of this can still be had for repairs, if its absolute necessity can be shown. Fortunately, it is frequently possible to fashion something from second-hand material that will serve the purpose, and the thought that, through your own efforts, you have saved a ton or two of steel for guns and ships will be so satisfying that the extra trouble and expense will be forgotten.

For some reason, steel reinforcing seems a little easier to obtain than structural steel, but, if necessary, we can do with a comparatively small amount of this material. We can't build long beam spans and structures made up of thin sections without reinforcing, but many of us have seen high walls and long span arches which were built without using a pound of steel, and to reassure ourselves that this can be done, we have only to examine a few of the fine old stone masonry structures that are still serving their purpose. Of course, this will require more concrete, but cement is still available, and I venture to say that with these thicker sections we will have less seepage than heretofore, with less disintegration from this cause. Some designers seem to have worked on the theory that if a few bars were good, more would be better. If this is true, perhaps it

is time to begin a new cycle before our concrete structures become nothing more than steel frames whitewashed with cement.

For the lack of steel sheet piling, we shall have to re-learn the almost forgotten art of building cofferdams of timber, with which our predecessors constructed deep and difficult foundations successfully, and with pumping equipment which to us today would seem totally inadequate. For the smaller culverts, for which we have used cast iron or sheet metal pipe in recent years, we now have triple-strength vitrified pipe, which can be substituted in many instances.

Shortage of Timber

Of equal concern is the present shortage of timber. We have always had plenty of that, and in an emergency nearly everything could be fixed up temporarily with it. Until there is some promise of improvement in this situation, not a piece should be wasted. Those roads which use treated timber are also faced with another serious problem, due to the acute shortage of preservative. Much timber is now on hand for seasoning, and unless it is treated soon it will deteriorate rapidly, either in the storage yard, or subsequently in a structure. The only thing that these roads can do is to use what oil is available to the best advantage, treating the oldest material first, and hope for more to permit the treatment of the remaining material.

Just as we were again beginning to consider, after a lapse of 10 years, that paint, after all, is a necessity, it too has become difficult to obtain. This may be a tem-

porary condition, due perhaps to the demand exceeding manufacturing facilities, rather than to a shortage of ingredients. But every bit of paint that can be obtained should be applied so that we can pass through a probable future paintless period better.

These are some of the major difficulties that we bridgemen face. No doubt, there will be others. Even in times of plenty, many small items are difficult to assemble and have on hand when needed. Now they may not be obtainable at all. There will be discouraging delays and the shifting of forces from one point to another, while

waiting for overdue deliveries or to meet some emergency, and there will probably be restless nights as well. There will have to be more careful planning and laying out of work. We shall have to revise our ideas as to what is essential and what is non-essential. We must in some way learn to spread the little available material thinner than ever before, and become accustomed to doing things the hard way. But all of this should make the next one, two or more years the most interesting in any bridgeman's life.

. . . For the discussion of this subject, see page 142.



**A Fully Preframed and Treated Structure Over
Antietam Creek on the B. & O.**

The Material Situation — As Seen By a Building Man

By O. G. Wilbur*

Appraisal Engineer, B. & O., Baltimore, Md.



O. G. Wilbur

With the material situation changing almost daily, in which materials that are available today may not be obtainable tomorrow, perhaps the best answer to the serious question of shortages now confronting us is the application of the engineer's ingenuity. Today we find ourselves doing things that, two or three years ago, or even during the period from 1931 to 1934, when most roads were just a jump ahead of the sheriff, we would not have considered doing. We have gone back to certain types of construction that were in vogue during the "Gay Nineties"—and, under the circumstances, why not?

There are several principal factors that we must keep before us very definitely in our job of keeping open the steel arteries of the great war production machine of our country. First, and most important, is the factor of safety—

*Mr. Wilbur, until recently field engineer in the building department of the Baltimore & Ohio, substituted on the program for A. L. Sparks, architect, Missouri-Kansas-Texas, St. Louis, Mo., who was unable to be present. In doing so, he included in his remarks, as presented here, considerable of the material which had been prepared by Mr. Sparks for presentation.

this must never be lost sight of. Second, and a close runner-up, is sanitation. Health must be guarded. Production and operation are seriously hampered if manpower is not kept in a healthy condition. Thirdly, I would list the factor of fire hazard. Here again we must recognize that our busy properties must be safe-guarded against loss by fire; otherwise we will be greatly inconvenienced in our operation. The loss of a shop building today, with its equipment, will, perhaps, present a more serious situation than at any time in the past.

The War Production Board is asking that all but the most essential construction be abandoned or deferred. I quote from its bulletin No. 1788:

"Every builder is urged to ask himself several questions and to give careful consideration to his answers before filing applications for authorization to begin construction. He should ask himself whether his project is necessary to the successful execution of the war. He should ask whether it isn't practical to rent or convert instead of building new. He should ask if his design is the simplest possible, just sufficient to meet minimum requirements. He should ask if all utilities—water, electricity, gas, etc.—needed for his project, are available.

"The sole criterion is whether the project is necessary to the prosecution of the war, or to maintain the public health and safety."

Some Materials Essential

Owing to the heavy increase in railway traffic and the resulting increase in forces, some building rehabilitations, extensions and enlargements will be essential, even though not connected directly with war industries. This is true especially because the railways have just emerged from a long period of curtailment into an unprecedented rush of business, and are finding that many of their small buildings are entirely inadequate. In many cases there is need for larger yard offices, more toilet and locker facilities, and similar structures where temporary emergency quarters are not available. On some roads, the major part of the materials for such construction is often comprised of salvage obtained by dismantling structures no longer needed, or by reducing the size of buildings which are larger than necessary. But even with the maximum curtailment of construction and the use of all available salvage, there will still be a need for some new material for essential construction and maintenance.

Railway men can contribute most in the conservation of critical materials by salvaging and reclaiming critical materials in buildings or other structures where such materials are not being used for essential purposes, and also, in all types of construction, wherever it is possible, through the substitution of non-critical materials.

Materials, including softwood

lumber, the use of which is restricted, should be used sparingly, even though priority ratings are granted for their purchase. The sale of portland cement is restricted in some localities, but not in all. In fact, comparatively few items of construction materials are unrestricted to the extent that they may be purchased in the open market without priority assistance. Among these are brick, natural cement, plaster cement, lime, gypsum, plaster board (lathe), coal tar pitch, portland cement (in some localities), gypsum blocks, roll roofing, asphalt shingles, 4-in. and 6-in. vitrified tile, clay tile, glass blocks, sheet glass and paint.

In some cities, building codes regulating the use of materials, and methods of construction, reconstruction, alteration, maintenance and repair of buildings or other structures have been partially suspended for the duration of the war, thereby allowing the substitution of materials and methods heretofore barred. It is suggested, therefore, that railroad men keep themselves informed in this regard with the view to using simplified construction on less important structures where more permanent construction would normally be required.

Liberal provision is allowed in the War Production Board's Conservation order for the use of second-hand materials where ownership is not changed, so that abnormally high dismantling and salvaging costs may be justified in order to retrieve these materials for essential construction. Heating equipment and plumbing fixtures and fittings are highly critical and difficult to procure with the usual priority assistance provided for

railroads. Therefore, it is possible that many railroads could well afford to set up their own shops for overhauling and reconditioning discarded valves and plumbing fixtures.

Old Plumbing Fixtures

Almost every unused building contains old plumbing fixtures of some kind. In many instances these items would serve the needs of the railroads and the country to a far greater extent by being put back into service through the reclamation shop, rather than by going into the scrap bin.

Electric wire and lighting appurtenances are also highly critical and difficult to secure. Large quantities of salvaged wire are usually made available in the dismantling of old buildings—also considerable conduit. Porcelain outlet boxes can be used, thereby enabling the reuse of much of this material, even if in relatively short lengths. Plastic electric fixtures and fittings, in which very little metal is used, are also becoming available. On the other hand, large quantities of materials, for which priority assistance is provided under WPB Order L41, will continue to be available for repairing buildings.

Possible Substitutes Listed

With patriotic and conscientious watchfulness, every building construction and maintenance man can render valuable service to his country by substituting non-critical materials for critical materials or those otherwise restricted or difficult to secure. Following is a list of such possible substitutions:

Gravity walls for reinforced concrete
Thicker concrete floors with less reinforcing

Brick walls for walls requiring hardware, metal lathe or lumber

Concrete floors on solid fills, for floors normally supported by beams

Wood trusses for steel

Plywood girders for steel

Laminated wood for heavy wood timbers

Salvaged wood for new wood where possible

Asbestos siding for drop siding and corrugated iron

Asbestos shingles or asphalt shingles for steel roofing



Many Classes of Building Repairs Are Essential, and Can Be Carried Out Without Employing Critical Materials

Bright roofing nails instead of galvanized roofing nails

Wood for metal gutters and downspouts

Composition flashings for metal

Various types of wood doors for steel rolling and other metal doors

Wood ventilators, monitors and skylights for metal

Brick chimneys instead of cast iron smoke stacks

Plaster or fibre board instead of wood for ceiling or wall sheathing

Brick, asbestos wall-board, fibre board or glass for steel toilet partitions and shower stalls

Masonry arches for steel or reinforced lintels

Wood, fibre board or composition lockers for steel lockers

Glass blocks and heavy wood sash for steel sash

Glass, porcelain and plastic lighting fixtures in lieu of fixtures of heavy metal

Scrap rail for trolley or monorail tracks in lieu of I-beams

Concrete and terra cotta pipe for metal pipe

Vitrified clay soil pipe instead of cast iron wherever possible

Wood or concrete manhole covers for cast iron. Wood where there is not much traffic. Concrete where traffic must be considered

Wood or concrete wash troughs for cast iron

Cast iron stoves instead of boilers, radiators or unit heaters

Wood or asbestos smokejacks for metal

Wood tanks for steel

Second-hand wood stringers for reinforced concrete pit walls

Second-hand locomotive air cylinders for new hot water storage tanks

Reclaimed, rethreaded bolts and nuts

Short wood ties laid diagonally on engine pits in lieu of heavy timber

Wood fences for metal

Since all construction is definitely limited by the War Production Board's Conservation Order L41 and will be affected further, no doubt, by subsequent interpretations and revisions, it is vitally important that all building men keep themselves informed currently regarding these matters.

... For the discussion of this subject, see page 142.



Salt-Treated Platforms Are Being Used on a Number of Roads

The Material Situation — As Seen By a Water Service Man

By G. E. Martin

Superintendent of Water Service, Illinois Central, Chicago



G. E. Martin

Since the water service departments of our railroads are substantial users of critical materials, we in these departments are in a position to contribute in a very definite way to the solu-

tion of the present critical material situation. Owing to the very limited amounts of certain raw materials available, our fullest co-operation will prove of great value to our country.

We must no longer expect satisfaction of all of our needs, and must realize that there are not sufficient raw materials to satisfy all requirements. The realization of this will necessitate the control of our desires to improve, and the use of all of our ingenuity to keep old plants operating as efficiently as possible for the duration. Plants that cannot be kept operating with present equipment should be replaced, but the wholesale installation of new plants should be avoided.

There are, undoubtedly, locations where, under ordinary conditions, it would be considered good practice to have duplicate pumping units. Today, at these locations, we should strive to "get by" with

single units, giving special or extra attention to these units where this is deemed necessary. Possibly a few repair parts available for immediate use would, in certain instances, serve satisfactorily in place of a second unit.

With the increased movement of military materials and men, all railroad facilities are being subjected to heavier loads. Water supply facilities are no exception. We have been called upon to restore plants that have been closed and to increase the capacities of others in order to supply locomotives with adequate, suitable water. Since the outcome of the war is dependent in a large way upon efficient rail transportation, it is essential that we meet these demands. To do this will, undoubtedly, require some additional equipment.

It is essential that those in government who are charged with the responsibility for allotting materials recognize this fact and give us the necessary aid to secure the amounts required. Failure to do this will, if carried too far, cause interruptions in railroad transportation which, in turn, will seriously affect our movement of men and materials.

It is our duty to make our requirements known in an effective way in order to avoid traffic delays. At locations where a thorough investigation develops the necessity for new facilities as

the only way to provide water needed for trains, we should give consideration to the installation of facilities to handle only the present requirements. Facilities of sufficient capacity to take care of present requirements on railroads will, no doubt, be adequate for a long time to come.

Second-Hand Materials

Second-hand equipment and materials that are usually made available when plants are eliminated because of changed conditions, or from plants where modern equipment has replaced old units, are a source of repair parts. These will serve to keep similar equipment in operating condition at a comparatively small cost, as well as to eliminate the necessity for the purchase of new parts. It is necessary that some definite plan be followed to secure the best results from the material salvaged in this manner. In my opinion, all water service material, excluding a working stock, should be assembled at one or two storehouses, where a water department representative should separate scrap material from material suitable for future use. Scrap material should be consigned to the scrap pile, while all usable material should be marked or tagged so that it can be identified readily by storehouse employees when filling requisitions. All of this latter materials should be handled in the same way as new material, and should be carried in storehouse reports for the information of the users.

All abandoned underground cast iron pipe lines should be removed where it is economical to do so, storing the pipe, valves and fittings

at the storehouse for future use. If there are locations where the amount salvaged exceeds the road's requirements, its sale will eliminate the purchase of similar new material by someone else. This will directly benefit the critical material problem. Similar salvage efforts should extend to pumping machinery, steel water tanks, and other water department equipment. In certain cases where it is not profitable to remove old facilities, reports of the conditions and materials available should be made to the Government agency set up for assembling scrap, allowing that agency to reclaim the materials for reuse or for scrap.

Collect Discarded Materials

The collection of discarded materials at outlying pumping stations should not be overlooked. It is frequently found that considerable amounts of scrap brass and second-hand valves have been put away in lockers or other places by pumpers and repairmen. Material of this character was probably set aside initially for use at some future time, but was forgotten with the passage of time. Pumpers and repairmen should be impressed with the importance of sending such material to a designated point for reuse. Poor housekeeping or untidiness about plants, shops, tool houses and other places where materials are kept or allowed to accumulate is one of the most prolific sources of material waste. The elimination of the "junk heap" and a good housekeeping program will produce considerable amounts of much-needed materials—and no priority rating is required to secure such material.

The purchase by requisition of materials and tools for ordinary running repairs requires close supervision to prevent the accumulation of things not needed. With the increased time now required to secure materials there is an inclination on the part of some to secure sufficient amounts for a longer period than ordinarily would

in this task. The fact that we have always used certain items manufactured from materials that are now very scarce is no reason why something else will not serve the purpose. The use of brass where iron will serve; the use of steel where wood will serve; the use of rubber where paper or cloth will serve; and the use of heavy

The Current, Adequate Maintenance of Water Facilities Is Essential to Uninterrupted Train Operation, and, at the Same Time, the Conservation of Essential Materials



be needed. Such a practice should be discouraged, since it only serves to deplete the material supply further. Material purchased and stored for future use often deteriorates much faster than if used immediately. A carefully-prepared maintenance program, with special effort to complete the work recommended, will do much to help anticipate material requirements. The avoidance of non-essential work will also eliminate or defer the use of some material until conditions are more favorable.

The substitution of non-critical material for critical material presents a challenge to all of us in water service work. Much can be accomplished by an honest effort

valves and fittings where standard weights will answer, are a few of the ways in which critical materials should be saved.

With the increase in railroad business, new men have been added to your organizations. These men require more training in the conservation of materials than some of the older men. The waste of material by inexperience and poor workmanship is probably one of the largest sources of waste.

The proper and constant maintenance of water-handling facilities does double duty—in saving material and in furnishing an uninterrupted water supply. The old adage, “a stitch in time saves nine,” is highly applicable in the mainte-

nance of water facilities. Making small repairs at the proper time will often save valuable material later. Maintenance men should be urged to be on the alert, giving all such cases prompt attention and not waiting until the part is damaged to the extent that new material is required. Much can be accomplished along this line, and too much emphasis cannot be placed on it. Men with the experience, judgment and energy to maintain assigned districts conservatively are invaluable, and will contribute in a large way to the conservation of materials.

Avoid Waste of Water

Water, while not classed as a critical material, does require critical material to produce it. Therefore the waste of water indirectly affects the use of critical material. The Illinois Central has long recognized the loss in this waste and was among the first roads to campaign against it. In the eyes of many people, water represents no particular value; consequently, the waste of it often goes unnoticed. Water in lakes and rivers does not represent any particular value, but when collected in a state suitable for use in a locomotive, it has a definite value. Therefore, it is evident that no waste of such water should go unnoticed. The water works man can control a large percentage of such waste. Hidden leaks reaching sewers are a source of large waste. The local maintenance man should be familiar with the location of all water lines and should check for leaks at regular intervals.

In our efforts to save materials or to substitute non-critical for

critical materials, it is essential that we do not overlook the small things while looking for the large things. We should keep in mind that nothing is too small to save. Collectively, the small things saved will result in large savings. Our efforts in this regard will not only be helpful to our railroads, but will give us a great deal of personal satisfaction in knowing that we are aiding our country in a time of her most serious trial and conflict.

DISCUSSION

President Dove: Gentlemen, you have the viewpoints of a representative of the War Production Board, of a bridge man, a building man and a water service man on this very important subject. For your benefit, and in order that you may get the most information on this matter of critical materials, Messrs. Hunley, Martin and Wilbur have consented to remain here to answer any questions you may have. Unfortunately, Mr. Beach was not able to remain. The meeting is open for discussion.

To start the ball rolling, I might ask Mr. Martin about the salvage of pipe lines. Can this be done at justifiable expense? Do you not think we have reached the stage where economy, as we are accustomed to think of it, is not the important factor in the salvage of materials; that getting the material itself and putting it in our stock, or into use, is probably of major importance?

Mr. Martin: I should say, in the main, that would depend largely on the need for the material.

President Dove: I think that it should be salvaged regardless of

whether or not there is an actual need for it on the particular road involved; some other road may need it badly.

Another thing that caught my attention was Mr. Martin's remarks about the waste of water. I think this thought can be applied to all materials, whether bridge and building or water service material. The waste of material is actually beginning to be looked upon as sabotage, because there can be no excuse for it in this time of need.

Treating Old Timber

S. T. Corey (C. R. I. & P.): The Rock Island is dismantling an old railroad about 75 miles long and is recovering an enormous quantity of untreated stringers. I wonder if anyone can tell me whether it would be practical to treat this material, if it is sound?

Mr. Hunley: What kind of timber is it?

Mr. Corey: Yellow pine.

Mr. Hunley: I would certainly try. This material should be salvaged, although, there is a very serious shortage of oil now, and I understand that it may get worse. There is some threat that next year we will not get any.

Mr. Corey: In your judgment, Mr. Hunley, would you consider that timber 20 years old would be too old to treat? Some of this timber has been in use for 20 years.

Mr. Hunley: At the present price of oil, it would cost about \$22 per thousand to treat it. When you consider the difference between no material and material that can be used, the money factor is not so important, because you must have

the material. I do not know why you could not treat it if it is still sound.

G. S. Crites (B. & O.): Where we throw out old stringers containing some sound wood, it is our practice to salvage the sound portions and to send them in for treatment for use in bulkheads and for blocking. The price, as we take this material into stock, is \$10 per thousand, and we charge it out after treating at \$25.

H. M. Church (C. & O.): Mr. Hunley, I would say that if these timbers did not have any decay in them, their treatment would be an excellent proposition. You will have plenty of air space in such timber, so they will be in good condition to take the oil. It is important, however, not to get too much oil in the old timbers in relation to the service life you want to get out of them. Conserve the oil as much as possible.

Mr. Hunley: We were talking about this early today. We have some of these old stringers too. We cannot treat them fast enough for lack of oil. In preframing them for roof trusses, some had small rotten spots, so we discarded them. I would much rather have a treated pine stringer, with a little soft spot in it, than to have no stringer at all. Such a stringer will certainly last a good many years, which is important right now because we are not going to be able to get much new timber for some time.

Mr. Corey: In connection with the removal of our old line, you might be interested to know that there are numerous lengths of cast iron pipe on this line. The question presents itself as to how much of this pipe we should recover. In one particular instance, there is a pipe

48 in. in diameter and 48 ft. long under an embankment of about 10 ft. If we recover the entire length, we will have to excavate about 120 cu. yd. Of course, we would have to leave enough opening for the natural waterway. I presume that under present conditions, we should recover all of this pipe. Ordinarily, I do not think we would pull out the end pieces and let the rest remain.

Mr. Hunley: Mr. Corey, even in times of plenty, we have salvaged such pipe. We have found that we can excavate for its removal with a crane for 50 cents a yard, and estimate that it is economical even for pipe of only 24 in. diameter. It is necessary that we forget the cost now. The main thing is to get the needed material.

Mr. Corey: I agree with you.

Mr. Hunley: Mr. Corey, if your pipe is 48 in. in diameter, it would pay you to take it out even if you had to excavate by hand. Of course, you would have to have a crane to pick it up.

President Dove: That verifies what Armstrong Chinn said this morning—that he had found it economical to go back on abandoned lines to recover the pipe which had been left. They had removed the end sections at the time of abandonment, but went back to recover the remaining pipe.

N. D. Howard (Ry. Eng. & Mtce.): In Mr. Wilbur's timely remarks, he presented quite a comprehensive list of possible substitutes for critical materials. In the interest of the members here, can anyone suggest further additions for this list?

Mr. Church: I might give just one instance that comes to mind.

Down on the East coast, the Navy is using laminated cardboard for column forms. The cardboard is in five plies and rather thin. It can be cut to length and does away with all wood or metal forming. You can secure this material in 20 ft. lengths. You just set it up with very little support and pour the concrete.

Mr. Dove: Is it used in the place of form lumber?

Mr. Church: Yes. Another instance is the use of low-grade lumber, such as No. 3 and 3-A, for forms. By this method, having sufficient support, you can make use of thinner plywood for the form lining for the finished surface of the concrete.

L. C. Winkelhaus (C. & N. W.): We are confronted with putting in five or six fuel lines for Diesel switches. In the old days, we would call up the car department and tell them what we wanted, but we can no longer do that. So recently, looking around, we found some bulk oil stations that had been abandoned. In fact, we bought one to get the tanks for these fuel oil stations.

Then the question of motor-driven pumps came up. These are so hard to get that I think we will have to bring out some of our old steam pumps and put them in service. In a couple of instances already, we have gone back to steam pumps.

F. G. Campbell (E. J. & E.): I am still thinking about the matter of treating old pine stringers. It just occurs to me that stringers 20 years old are probably almost 100 per cent hardwood and full of resin. They should treat very well. But I am wondering if they have

lasted for 20 years without decay, if they are not still pretty good without giving them any treatment.

Mr. Church: I would say that using lighter oil, there is still opportunity to get adequate penetration to give them added service life.

Mr. Campbell: The treatment would help, of course.

Salvaging Materials

J. P. Hanley (I. C.): In regard to Mr. Martin's remarks concerning the conservation of water service materials, which were very timely, it occurs to me that possibly the water service man has been crowded between two forces. One of these is the government's idea of securing all the scrap possible, which we all endorse, and the other is to avoid the use of as much new material as possible. Between the two, I am afraid that we may have scrapped some usable material. I have in mind particularly pipe and valves and fittings for which there was no immediate use. They possibly were not in very good condition to put in the storehouse, but it occurs to me that as long as the cost of this material is only secondary at the present time, we would be justified in spending a considerable amount of money to reclaim this second-hand material for further use. The shortage of materials appears to be growing progressively worse, and while it is possible that a large amount of usable material may have been already scrapped, I believe we should be alert from now on to hold out any reclaimable material for possible use in the near future.

The same condition prevails with

regard to wood water tanks. Our road, and other roads, no doubt, have wood water tanks which may be scheduled for retirement. Quite often the frames under these tanks are of creosoted material. Possibly the tubs and the staves and the bottoms of these tanks are of untreated material. I believe that the bottom planking and staves should be culled over carefully, and that all the usable material should be reclaimed and sent to certain designated storehouses on the division, or to some other point, where it can be used in repairing other old tanks.

The Illinois Central has 25 or 30 tanks that are 25 years old or more, and all of these tanks will be requiring some new pieces before long. It is my thought that instead of scrapping released material, it should be culled over very carefully, with the idea of reusing much of it.

Mr. Church: I noticed in the last issue of the Wood Preservers' News, the suggestion of using plywood for washers in place of washers of cast iron and steel.

President Dove: Going back to the remarks of Mr. Corey and Mr. Hunley, I think it is quite evident that the railroads are working together on this material situation. It is possible that an arrangement may be worked out whereby what may be of no immediate use to one railroad may be thrown into a pool for use by some other railroad. Those reclaimed valves which do not look good enough for storage purposes might be used by some other road.

Mr. Hunley: With regard to Mr. Hanley's remark about salvaging wood tanks, such work has to be

done very carefully. The Big Four started using creosoted tubs in 1907. The first of these tubs is still in service. Before the Illinois Central started using creosoted tubs, Clarence Knowles came down to talk with me about what our experience had been with them. On the Big Four, we have not used anything but creosoted tubs since about 1916. We have now taken down those early tubs and salvaged them, but it is very difficult to get a complete tub from any of them. They always break in the chime, and they are very difficult to reframe. We have even tried that. The staves are all matched, of course, and it is difficult to get more than one tub out of two. Even to do that, it is necessary that the work be done very carefully.

Creosoted tubs always swell. If you have the correct number of staves, there always appears to be one or two too many. We first accused the tank manufacturers of not sawing the bottoms circular, because we found out that when we erected the bottom, it was 30 ft., 3 in. across the grain and 30 ft. the other way. That was due to swelling from the treatment.

So while those creosoted tubs can be salvaged, it is very difficult to get a complete tank, and then you must always fit your staves carefully. It is quite expensive to work these old tanks over.

Mr. Church: I am wondering, Mr. Hunley, whether if you put a six-inch concrete bottom inside the tank, you would help stop leakage? I have had tanks 30 years old that were carried 10 years longer by putting in concrete bottoms.

Mr. Hunley: We tried that, too, but in taking the tank down, often

the staves are broken off at the chime. When that is done, the only thing you can do is to cut the staves off and re-dap them. That takes special machinery.

Mr. Crites: On my section of the B. & O., within the last two or three years, we have taken down four tanks and replaced other decayed tubs with the tubs from the old tanks. In these instances, we had the same gang that took the tank down put it up again, and we had none of the troubles of which Mr. Hunley has spoken.

Mr. Winkelhaus: Mr. Wilbur read a list of specific substitutes for critical materials. One substitute I have in mind apparently does not appear on this list. We do not know how much longer asphalt and mastic materials will be restricted, but we have found a new substitute for them in platforms. It is water-bound macadam. Some two years ago, in joint facilities with three roads, we used several yards of it, and it has proved to be very satisfactory. I would recommend that where you are putting in a new platform and can not get the type of material you want, you try water-bound macadam.

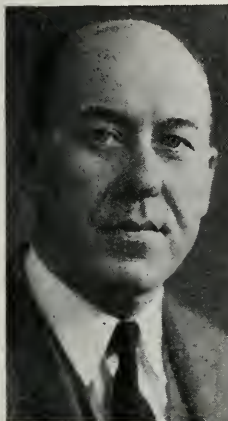
Martin Meyer (C. & W. I.): I think an important phase in the conservation of material is to keep things painted. I have in mind particularly light sections of steel gutters, leaders, downspouts and all that sort of thing which if not taken care of might deteriorate to the extent they will require replacement before the war is over.

President Dove: Gentlemen, I believe that completes our discussion. I want to thank the gentlemen who have so ably presented this program on materials.

The Repair of Steel Bridges

Report of Committee

Committee—A. R. HARRIS (chairman), asst. engr. br., C. & N. W., Chicago; A. B. CHAPMAN (vice-chairman), off. engr., C. M. St. P. & P., Chicago; J. M. SALMON, JR., (vice-chairman) asst. div. engr., L. & N., Middleboro, Ky.; H. M. BUELL, br. insp., U. P., Omaha, Neb.; R. W. CASSIDY, asst. cost engr., C. & O., Richmond, Va.; P. C. CHAMBERLAIN, br. insp., Erie, Port Jervis, N. Y.; D. W. CONVERSE, asst. engr., A. C. & Y., Akron, Ohio; L. M. FROST, supv., b. & b., G. T. W., Battle Creek, Mich.; J. E. HECK, br. insp., C. & O., Peru, Ind.; A. M. KNOWLES, asst. engr. str., Erie, Cleveland, Ohio; I. A. MOORE, trainmast., C. & E. I., Salem, Ill.; R. H. MORRISON, supt., b. & b., Ban. & Aroos., Houlton, Me.; G. L. SITTON, ch. engr. m. of w., Sou., Charlotte, N. C.; and J. J. WISHART, supv. b. & b., N. Y. N. H. & H., Boston, Mass.



A. R. Harris
Chairman

Bridges are as important to the safety and usefulness of a railroad as links are to a chain. Just as the load capacity of a chain is limited by the strength of its weakest link, so are the locomotive and train load capacities of all or a section of a railroad

limited by the strength of the weakest bridge. In the one case the links, and in the other case the bridges must be maintained in good order to sustain the loads for which they are designed.

The railroad slogan "Safety First" applies as appropriately to the care of railroad bridges as it does to the many other details of railroad operation. Bridges, like other railroad property, become weakened by wear, deterioration, and damage from accidents and various other causes and a constant search must be maintained to detect the weaknesses which develop from time to time in the parts of bridge structures, especially the steel super-

structures in which the element of safety is very important.

Inspection, therefore, is a very important factor in the care and safety of bridges. It is also important that a bridge inspector have the proper training and experience and an inquisitive mind to search out the weakened parts and report such conditions understandingly. The more he knows about the theory of stresses, the better he can do this and give proper weight in his reports to defects in critical members and in unimportant members of bridges. He can also be helpful in suggesting types of repairs which will accomplish a useful purpose. Carefully prepared field inspection reports make it possible for the bridge office to prepare plans for adequate and satisfactory repairs where needed and avoid unnecessary and poorly conceived repairs.

It is important that adequate provision is made in the construction of a bridge to enable an inspector to get around over the principal parts with safety. In some cases catwalks, ladders and grab irons are necessary accessories for this purpose and if not provided in the original construction, they should be added as their need is demonstrated.

While an inspector should be equipped with a light ladder, bar, calipers and a carpenter's rule, sometimes an extension ladder and addi-

tional help are required to get at ordinarily inaccessible places, and it is necessary to move planking, ties, etc., in order to make detail inspection and measurements of parts of some bridges. It is always desirable to make a special inspection of steelwork that is ordinarily concealed but that is exposed during the renewal of timber

fabrication of repair parts, is done by company forces, a stock of steel sizes should be ordered for all or parts of the program as early in the year, following the preparation of the program, as possible to avoid delays in executing the work. Plans of practically all repairs should be made, not only to insure proper execution of the



Welding Is Being Used Extensively in a Wide Range of Repair Work on Steel Bridges

and decks at the time of making repairs, when the assistance of the bridge gangs will be available.

Programming the Work

The inspection reports written during the year as soon as the inspections are made, form the basis for a program of repairs for the following year, except in emergency cases when conditions make it necessary to make repairs sooner. This program should be set up before the end of the year, listing each job separately, with an outline of the work contemplated and an estimate of the cost for authorization. While it is not necessary that detail plans of the repairs be made prior to preparation of this program, it is better to do so if time permits; otherwise the plans can follow later.

If the repair work, including the

work, but also to have an office record of the repairs made from year to year. In case the repair work and the material therefor are handled by contract, there is even more need for complete plans. Often, when repairs are under way, more extensive repairs are found to be necessary.

Field Organization for Steel Repair

Many railroads do all their steel repair work with company forces, organized into floating gangs of from 6 to 14 experienced ironworkers with a foreman. The number of the gangs depends on the size and nature of the work to be done. When larger gangs are required for any special job, two or more gangs are combined.

If welding in addition to the usual riveting methods is employed in making repairs, when it is practical to do

so, it has been found desirable either to provide complete welding equipment for the gang or if a less number of welding outfits are available, they may be transferred from one gang to another as required. Only specially trained men should do the welding but they should also be able to do riveting in case there is not welding enough to keep them so employed continuously. The gangs should be under the direction of a general foreman or supervisor, who, in turn, works under the supervision of the bridge engineer.

Repairs

(a) Steel repairs can be studied conveniently by considering the various types of repairs to be made. The type to be made may be influenced by a consideration of the time available between trains, but generally it is possible to install new members without interruption to train schedules by the following method: Cut out rivets and replace them immediately with temporary bolts. When all the rivets have been cut out, remove the bolts, take out the old member, place the new member, and bolt it up temporarily. Then, at the gang's convenience, drive the new rivets.

(b) Repairs required on account of brine corrosion:

Riveted Cover Plates on Stringers and on Deck Girders Without Cover Plates. Where the top surface is not pitted severely, cover plates are added. Pitted surfaces cannot be leveled satisfactorily. The rivet spacing should preferably not exceed 6 in., to avoid the accumulation of rust between the cover plate and the old member. The rivets should preferably be countersunk (not chipped). If buttonheads are used, the ties may either be grooved or bored to clear rivet heads, unless, as is done on some roads, the ties are placed on the rivet heads and

the first train passing over the bridge is depended upon to press the ties down over the rivet heads.

Welded Cover Plates. Plates preferably not less than 10 in. wide, in order to get good tie bearing, are added to the top flange, using continuous fillet welds for attachment to the angles. Cover plates are added to the bottom flange, making the plates wider than the flange to permit downhand welding. The edges of the flange angles, where severely corroded, should be trimmed back to obtain a reasonable thickness for welding.

Additional Angles: Where the top flange angles are too greatly pitted and reduced in section for satisfactory application of new cover plates, additional flange angles are added immediately below the bearing flange angles. Timber fillers may then be placed tightly between the two sets of angles. Eventually the top angles will need to be replaced with new angles, but the lower top flange angles will maintain the strength of the flange while the upper top flange angles are being changed out. This type of repair has merit at locations where train schedules are frequent.

Tie Supports: Where the top flange consists of angles without cover plates and is too badly pitted to permit attaching cover plates, they are trimmed back to the face of the web rivet heads, and a new fabricated flange, composed of two angles and a cover plate, is placed over the old flange. Lower top flange angles are then added to make up for the flange section cut away and the new flange is bolted with long bolts to the lower top flange angles. This detail affords a good support for the ties. (An illustration of this detail appears on page 93 of the 1936 Proceedings, of this association.)

New Flanges for I-Beam Stringers: Holes are drilled in the webs under

the flange to match the holes in new flanges composed of two angles, or two angles and cover plates. The top flange is removed by a horizontal flame cut just below the flange, and a new flange connected to the web of the stringers. This method may be economical where heavy stringers are involved and their replacement will entail the temporary removal of lateral bracing angles.

Cover Plates of Floor Beams: Where the corrosion is confined to a

cover plate installed, providing extra material to allow for corrosion. The rivets cut out are replaced temporarily with bolts to maintain traffic over the bridge until all the rivets are cut out.

Floor Beam Webs: These become corroded as a result of brine splashing against the web on the side facing traffic. Patch plates are placed over the corroded area, preferably connected by welding to the end connection and the flange angles.

Bottom Flange Repairs: Where the bottom flange angles have corroded, it is not logical to apply cover plates on the bottom as the corrosion will continue on the flange angles. Instead, plates or angles should be riveted or welded to the upper side of flange angles. The plates should be ground to clear the fillet of the flange angle and carried over to the vertical leg of the flange angle. On deep stringers without stiffeners, new flange angles are placed directly above the old flange angles. The new angles will shield the bottom angles from brine drippings.

Corroded End Stiffener: Where the corrosion is confined to the lower six inches of the outstanding leg, a plate is riveted to this leg, taking the precaution to drift tight against the flange before riveting. Additional short stiffeners may be added between the existing stiffeners, but the bearing base details should be checked to see that the new stiffeners will not create high bending stresses in the top of the base.

If welding is used, the corroded part of the stiffener is cut out, and a new plate butt-welded to the stiffener and V-welded to the bottom flange. The A.R.E.A. Specifications sanction the welding of the end stiffeners to the flange. It would appear desirable always to weld the stiffeners to the flange, as the flange will be corroded, and a good bearing cannot be obtained by simple contact.

Stringer Renewals: Where the old



Renewing Cover Plates by Both Riveting and Welding Is An Effective Means of Girder Repairs

small area, the corroded part of the cover plate is cut out, replaced with a filler plate and spliced over with a new plate, or a plate with holes to clear the rivet heads is welded over the old cover plate. Another satisfactory method is to remove the corroded sections of cover plates and replace with new sections butt-welded to the ends of the old plates. These plates may be riveted to the old flange section. Where the top cover plate is badly pitted over most of the length, all rivets should be cut out, and a new

stringers are of good rating, two to four new stringers can be furnished, and the old stringers taken out and repaired on the ground, and then re-erected in a new location.

Bottom Flange of Girder at Bearing: Frequently the outstanding legs of the flange angles are corroded, or the flange angles just outside of the sole plates have been bent down $\frac{1}{4}$ in. to $\frac{1}{2}$ in. A suitable repair is to remove the sole plate and cut off the corroded or crimped outstanding legs, making a horizontal cut through the vertical legs and web of the girder. Then a new plate is inserted to take the place of the legs of the flange angles cut away, and a new sole plate, extending about two feet beyond the bearing, is installed to splice to the flange beyond the bearing. This detail requires welding. Where both legs of the flange angles are corroded, a short length of the angles should be cut out, and a new section installed, using lap angle splices outside of the bearing.

Corroded Webs Above the Rail Plate Floor, or Solid Floor: Around terminals there is an accumulation of dirt and cinders along the corner between the web and the floor, and the web may be corroded entirely through. Welding is the best means to apply patch plates, which are seal-welded to exclude moisture.

Repairs to Stringer Flanges Required on Account of Fillet Cracks Resulting from Bending of Ties, or From Other Causes: At the ends of stringers, fillet cracks will frequently be found, apparently caused by the deflection of the tie. Short angles are riveted inside the flanges and serve the dual purpose of supporting the flange and preventing the extension of the fillet crack. Where the fillet cracks occur at points other than the ends of stringers, it is preferable to renew flange angles with thicker material.

Connection Angle Repairs: Due to continuous beam action at stringer connections, the connection angles are frequently cracked through the fillet, or through the material between rivet holes in the outstanding legs. The connection angles should be renewed with heavier angles. In case the stringers are long and flexible, it may be well to redesign the connections, using two lines of rivets in each connection, and cutting down the depth of the connection. This method has proven satisfactory in the case of 110-ft. twin span turntables where the flexing of the connection angles at the loading girders results in fillet cracks at the top and bottom.

Bearing Repairs: Cracked cast iron bases should be replaced by welded bases, which are more economical than cast bases. The welded bases may have the same make-up of ribs and top and bottom plates as the old bases, and be welded at all intersections with $\frac{3}{8}$ -in. fillet welds. No annealing of the welded base is necessary. The top and bottom surfaces will require planing after welding, and the thicknesses of the top and bottom plates should allow for this planing. Where the stiffener layout is favorable, the new welded bases may be made of a simple design, using a less number of ribs than in the old base. It is well to provide additional holes in the base so the anchor bolts can be placed in new locations. The old bolts may be cut off to save the expense of jacking the span high enough to allow setting the bases over the old bolts.

Shims: At many bridges there is an accumulation of steel shims which is the result of surfacing the bearings to overcome wear or settlement, and raising the bridge to conform to the track. Where there is a large accumulation of shims, the girders often shift on the bearings. The individual shims should be edge-welded together to

form a single unit, or else replaced by a new slab or pedestal. At old bridges, the masonry bearing is generally inadequate, and the replacement of the shims affords opportunity to furnish a new steel bearing slab of greater area. At such locations the masonry under and outside the bearing should be dressed down to a level surface.

Where the shim thicknesses are small, it is desirable to place the shims between the sole plate and pedestal.

Setting Bases: Where the bridge seat is at correct elevation, dry cement may be used to level off irregularities. Wet sacks can be laid around the base and the cement will abstract sufficient moisture to set. Sheet lead, or canvas saturated with red lead, or a rust joint may also be used to smooth out irregularities.

Rivets, Machine Bolts and Rib Bolts: Rivets are desirable for all connections. At isolated locations where a compressor is not available, bottled compressed air may be used for driving rivets, or machine bolts or rib bolts may be used for unimportant bracing connections. If bolts are used, it is essential that lock washers or lock nuts be used. Rib bolts must be large enough to drive tightly, or they will loosen up and not be satisfactory.

If the steel members have not separated, corroded rivet heads are built up by welding, using a bead weld around the periphery of the shank and taking precaution to secure good penetration.

Eye-Bars of Trusses: Frequently one of the several eyebars of a member will be loose and not tighten up when the span is fully loaded. Such a bar may be shortened by heating with acetylene torches and up-setting. This method is satisfactory and economical. Another type of repair used is to cut out the bar and install a turnbuckle. When the pin and all of the bars are worn, the bars should be rebored and

a larger pin installed, but this should not be so large as to reduce the section of the bar materially. When the bars have been reduced in section by blast in the center of the panel, bars may be welded to the sides of the eyebars to restore their original strength. In many old light truss spans, the panels near the center of the span do not have counters, and the diagonal eye-bars will slack up for a certain position of the live load. Counters may be added by placing yokes around the pins or around the heads of bars.

Railing Repairs: The old pipe railings are usually of thin material and the posts break off near the bottom of the threaded connection. The pipe posts should be removed and angle posts installed, connecting the railing by U-bolts or by special fittings.

Turntable Repairs: Most of the repairs are required on account of corrosion, but there are a few points that deserve special mention. The friction at the center may develop a large bending force at the bottom flange of the loading girder. In one instance all of the cover plates had transverse cracks at the edge of the center bearing. Bracing was installed to relieve the flange of transverse bending stresses. On through plate girder turntables, it is important that the span be level in a horizontal plane; otherwise the girders will be forced back and forth in a scissor-like fashion, and complaints will be made that the span does not have sufficient stiffness or bracing. At one such location, a tapered steel shim was placed over the center bearing, leveling up the span properly, and all of the operating troubles complained of disappeared.

Allowance for Corrosion

Where repairs are required, the new material should generally be of heavier section to provide against breaks or to

allow for corrosion. Special alloy steels, or wrought iron may be considered. Wrought iron has proved to be more corrosion-resistant than ordinary steels, but the alloy steels have not been in service long enough to prove their value. It is doubtful whether the ordinary copper-bearing steel should be considered corrosion-resistant steel.

Welding

Welding possesses a great advantage over riveting in that in many instances material may be added to existing steel work without cutting out rivets, and thus temporarily reducing the strength of the structure. It also has the advantage that material may be applied with less interference to traffic than by riveting.

Research at the University of Illinois indicates that welded joints compare favorably with riveted joints under repeated loadings up to 2,000,000 cycles. A properly prepared butt-welded joint appears to be more free of localized stress concentrations than a riveted joint, and considering that 20 per cent of the net section is lost in the riveted joint, welded structures will show 10 per cent to 20 per cent saving in weight over riveted structures. The butt-weld should always be employed for compression or tension members where practicable in preference to fillet welds, as fillet welds have stress-raising characteristics.

DISCUSSION

G. S. Crites (B. & O.): At one point, the report says: "At such locations, the masonry under and outside the bearing should be dressed down to a level surface." I should imagine that this has reference to the time when granite bearing stones were used and, of

course, the masons made the top level. To prevent the running of water under the bearing, the top, outside of the bearing proper, should be sloped away from the bearing to carry the water away from, rather than under the bearing.

Chairman Harris: I think this is a very good suggestion. Where there is a depression under the bearing, it is certain to hold water. It would be well to dress down the masonry so any water will run off the sloping course.

President Dove: Mr. Garis, do you have anything to add?

L. D. Garis (C. & N. W.): I think this report, taken in connection with the report published a few years back by the special committee of the A.R.E.A. on typical failures in steel bridges, contains the most valuable information that is available for the person who is interested in inspecting and repairing steel bridges. The thing that has most concerned me as an inspector is the question of how far brine deterioration or loose rivets should be permitted to develop before repairs are made. Perhaps members of the committee have information as to when it is good practice to make repairs.

Chairman Harris: It was intended that this report cover strictly the repair of bridges and not the strengthening of bridges, which was covered adequately in the A.R.E.A. proceedings. No attempt was made to cover the subject of design, as it was felt that this too had been covered adequately.

But our particular subject—of selecting types of details for repairing members of bridges damaged by corrosion and breakages

—has not been covered previously, to my knowledge, in any report of this association or the A.R.E.A.

We did not bring out in our report as well as we might have what can be accomplished these days by welding and flame-cutting equipment. Today, you can go out and do almost as much with a steel bridge as with a timber bridge. You can cut the steel on the job and fit it and weld it up. I think you could almost build a bridge from plain material on the job if you had the necessary cutting and welding equipment. In fact, there is an article in the *Welder's encyclopedia* describing how a bridge in Florida was fabricated in the field by cutting and welding.

I would welcome some discussion on methods of making various types of repairs, if anyone does not believe that the practice outlined in the report is the best to be followed on his particular railroad.

Building Up Rivet Head

W. R. Roof (C. G. W.): I wonder if anything has been brought out about the restoration of brine-eaten rivet heads by arc welding.

Chairman Harris: No, there has been no discussion of this problem.

Mr. Roof: We have done quite a bit of this on the Chicago Great Western; that is, the restoration of rivet heads by arc welding a fillet around the top of the rivet head where it is completely or partially deteriorated. It has worked out quite satisfactorily and is much more economical and easier to do than removing old rivets and driving new ones.

Chairman Harris: I think such a practice would be entirely practicable unless the rivet heads are

so far gone that the plates have sprung apart, then you must find some method of drawing the plates back together.

Mr. Roof: In some places the rivet heads were practically gone, but there was no spreading of the plates. By running a continuous fillet around the shank, the rivet shank is fused to the plate, and this is as good as a rivet head.

R. E. Caudle (M. P.): I would like to inquire whether this practice of building up rivet heads is protected by patent.

A. M. Knowles (Erie): No, it is not. I say it is not because not long ago in a suit against a railroad which had used this type of construction, in which it was claimed that the method was covered by patent, it was decided that the patent was null and void. We did quite a bit of this work even before the person bringing the suit had a patent; in fact, we were one of the principal roads, I think, to help void this patent, as we have been building up rivets for quite a number of years. In 1929, we started restoring rivet heads by welding to some extent, and in later years we developed a metal form to set over the rivet, in which you could form the rivet head quicker than by hand without such a form. This has worked out very well in some cases. On the other hand, some welders are so proficient in their manipulation of the welding arc that they can build up a rivet head quite well without any metal form. They are not always perfect in shape, but they serve the purpose very well. As you have said, where you have the room and can do the work without too much disturbance of

the track deck, the method is all right.

Mr. Roof: Why is it necessary to restore the complete rivet head? Why isn't a single fillet around the edge of the rivet shank, fused to the adjacent plates, sufficient? To complete the contour of the rivet head is a waste of essential material and labor, and adds nothing to the strength.

Mr. Knowles: I do not want to speak for the chairman of this committee on this, but I will say we feel that a flat rivet head, which you would have in such case, is subject to corrosion again, and the less material you have there to deteriorate, the quicker you will have a loose rivet head again. The idea is to build up enough shoulder outside the shank to hold the plates or angles together and in place, and keep them from spreading. The standard rivet head is shaped the way it is because of the way it is driven. You do not have to replace that head in the same shape, but you should have enough head built up to last a reasonable time.

Shortening of Eye Bars

J. S. Hancock (D. T. & I.): We have adjusted loose eye bars on old trusses by welding properly designed on turnbuckle units. These turnbuckle units have been in service for five years. To date, they have been entirely satisfactory. We have welded turnbuckle units on as many as three eye bars out of four in a lower chord member. This method of repair enabled us to continue the use of five old truss spans. Many of the eye bars in these spans were out of adjustment. In one instance, one bar out

of four in a lower chord member did not carry any load. This method of repair can be executed very well under traffic as the turnbuckle unit is welded in place and is tightened securely before a section of the eye bar is cut out between the ends of the turnbuckle. The final adjustment of the turnbuckle unit can be done easily between trains. Equal adjustment can be determined by equalizing the number of vibrations per one-half minute and by the use of strain gages.

A. B. Chapman (C. M. St. P. & P.): I would like to add a word about the shortening of eye bars of bridges. We have tightened bars on several bridges this year. On some of the bridges we shortened as many as 40 bars. One eye bar was shortened $1\frac{1}{4}$ in. to bring it up to equal tension with the other bars. The bars were shortened by heating with torches and then upsetting them. The upsetting was done by placing clamp plates on the bar, with bolts to draw them together. Sometimes it would take as much as seven or eight heats to draw the bar up tight. Where the bar is not very loose, the shortening can be done in 30 min. If there is 30 min. between trains, the bar can be shortened and cooled sufficiently to carry the train load safely. We think this method is very much better than the turnbuckle method, which we used previously. It is much faster and so much cheaper that we have abandoned the other method entirely.

Mr. Roof: Is that process patented?

Mr. Chapman: Not that I know of. We developed it ourselves.

Chairman Harris: I do not believe that process could be patented, because I read a description of it in connection with a highway bridge repaired in 1923, and, to my knowledge, no patent had been taken out at that time.

Mr. Knowles: May I ask Mr. Chapman what assurance he has that he has not injured the bars by re-heating, particularly where two or three reheats in the same bar are required?

Milwaukee Method Tested

Mr. Chapman: Before we did any of this work, we took bars that had been heated and shortened, and again reheated them. We then made tests and found that each bar was as strong or stronger than the original bar. Heating 12 in. of a bar will shorten it $\frac{1}{8}$ in. A 6-in. heat will shorten it $\frac{1}{16}$ in., and other heat lengths will shorten proportionately.

As to the strength of the material, we made tests of the shortened bars, and in no case did we find that they broke at the point of upsetting, and in no case under a load less than the normal strength of the bars.

Mr. Knowles: How are you assured of getting the proper tension?

Mr. Chapman: One can determine the proper amount of tension by shaking the bar. We have made strain gage tests on bars which have been shortened to see how much tension was put in them, but normally a man who is experienced can determine this quite accurately when he has even tension in all of the bars. We started the use of this process in Chicago on one of the worst bridges we had

on our road. We shortened one bar $\frac{5}{8}$ in. and at first thought that sufficient, but the bar was still badly bowed. So we continued to reheat and upset it until we had shortened it $1\frac{1}{4}$ in. Then all the bars seemed to have an even tension. Later, we took off the pin nut to determine how much play there was around the pin, and found that it was wear of the pin hole that had caused most of the looseness.

Mr. Knowles: When reheating, do you reheat in the same spot or in another one?

Mr. Chapman: It does not matter whether you reheat in the same spot or in some other place, but usually, we move away and heat in a different place. We use a pyrometer to determine the temperature of the bar, so that in no instance does it exceed 1600 deg. F. No live load is permitted on the bridge until the temperature returns to 200 deg. Steel between 500 and 900 deg. is in its weakest condition; that is, if you distort steel in that range, you are apt to cause failure. So we always use a pyrometer to determine the heat, and do not let any trains over until we get below 200 deg.

President Dove: This has been an interesting discussion. Is there any further comment?

More on Rivet Heads

Mr. Garis: There is something I do not quite understand about this building up of the heads of rivets. In my experience as an inspector, I have seen many rivet heads which had been greatly reduced by corrosion, but I have never seen that situation where there was not a considerable amount of reduction in section of the steel mem-

bers being held by the rivets. Of course, I have also found a great many rivets with the heads snapped off, especially in stringer connections to floorbeams. I think one of the usual causes of these headless rivets is some error in the length of the stringers. As I remember, a designer never puts much faith in rivet heads. I wonder under just what conditions it would be economical to simply build up rivet heads. I do not know of any building up of rivet heads on the C. & N. W.

Mr. Chapman: In very few cases have we found it cheaper to weld on a rivet head than to replace the rivet. Usually, we can knock the rivet out and re-drive it at less expense. In many cases, the rivet has started to bleed and we have had to re-drive it anyway to make certain that we get a good tight job. But there are many cases where the rivet heads alone are gone, as corrosion seems always to attack this point first. Brine and other conditions causing corrosion always attack where there is the least paint, and the rivet head is usually where it starts.

More on Eye Bars

Mr. Knowles: I would like to ask Mr. Chapman when he applies the squeezing process on the bars to bring them up, since he does not rely entirely on heat for shortening.

Mr. Chapman: In most cases we apply a bar on each side and bolt it through to hold it, and then run our rods through. We usually put these on before we heat them, because we do not know how much it is going to have to come up. The judgment and experience of the men performing the work tells them whether it is necessary to apply the turnbuckles or to tighten up on the rods. It does not pay to go too far. If you do, you are likely to shorten too much, and it is harder to take the shortening out than it is to put it in.

Mr. Crites: Relative to the question asked about building up rivet heads, and the answer that probably the rivets should be driven out and new ones placed, there are many overhead bridges supporting a railroad over a railroad, or supporting a highway over a railroad, in which the under heads of the rivets were not proofed against corrosion. In such cases, especially where there is a solid deck, the rivets cannot be driven out without demolishing the deck. In such cases, the rivet heads should be built up by welding.

President Dove: Is there any further discussion? If not, we will dismiss the committee with the thanks of the association for their splendid contribution to our library.

Piles and Pile Driving

Report of Committee

Committee—W. F. MARTENS (chairman), gen. for. b. & b. & w. s., A. T. & S. F., San Bernardino, Cal.; J. F. LOCKWOOD (vice-chairman), supv., b. & b., C. & O., Richmond, Va.; C. F. BERG, engr. dftsman., C. & N. W., Chicago; L. G. BYRD, supv. b. & b., M. P., Poplar Bluffs, Mo.; B. J. CHAMBERLAIN, scale supv., C. & E. I., Danville, Ill.; R. L. COOK, asst. engr., M. P., Houston, Tex.; M. H. DICK, eastern editor, Railway Engineering and Maintenance, New York; F. G. ELMQUIST, br. insp., C. M. St. P. & P., Chicago; P. V. ELFSTROM, dftsman., C. & N. W., Chicago; L. I. EVANS, instman., C. M. St. P. & P., Savanna, Ill.; O. M. GLANDER, ch. carp., C. M. St. P. & P., Mason City, Iowa; A. E. KILES, b. & b. carp., S. P., El Paso, Tex.; J. B. LODESKI, asst. br. insp., C. & N. W., Chicago; J. F. MONTGOMERY, supv., b. & b., St. L. & S. W., Tyler, Tex.; and E. E. TANNER, gen. supv. b. & b., N. Y. C., Albany, N. Y.



W. F. Martens
Chairman

Economy requires that the proper length of piles be determined in advance. A careful exploration should be made of the soil in the absence of definite information regarding piles previously driven at the same location and if the job is of sufficient magnitude.

Driving test piles is desirable, since it furnishes, in addition to the proper length of piles, information as to the time required to obtain the necessary penetration and hence the approximate time for driving piles later. If it is not expedient to drive test piles, exploration should be made by sounding rod, earth auger, wash borings, core drilling, boring machine, or test pits. Tests should be made at proper intervals for the entire length of long pile trestle bridges, at the location of all piers and abutments, or at several places properly distributed for a

building foundation. Failure to make adequate tests to determine the proper length of piles may result in waste of timber in excessive cut-offs, or closing down the work because of the piles being too short and having to arrange for longer material. In the case of metal or concrete piles, the excessive cost of material, labor and time could be very costly, as well as seriously delaying the work.

The pile driver still is of the first importance in the construction of pile trestles and foundations requiring bearing piles. Present-day train schedules and density of traffic require a track machine of modern type, that, with idler car and tender car attached, can move under their own power, at a speed of not less than 20 m.p.h. The driver should have at least two speeds, the lower for spotting the machine during pile driving operations, and starting, and the higher speed for making moves requiring faster running.

The trend in pile driver design is toward air controls in lieu of the conventional levers for manipulation of the hoisting drums and swinging and traveling mechanisms. Dual purpose machines are not desirable, except when there is insufficient work to justify a single-purpose rig. While there still exists a difference of opin-

ion with regard to the relative merits of the single end and the full revolving machine, the trend is definitely toward the latter.

Track pile drivers should be capable of handling a load of 20,000 lb. in the leads at right angles to the track without employing outriggers. The leads should be not less than 50 ft. in length and equipped with a power-operated battering device. A winch head is a necessary adjunct.

Gasoline engine or steam turbine-operated generators to supply current for electric lights and an independent compressor for furnishing air to operate pneumatic tools should be standard equipment. Off-track pile drivers have not been used to any extent for driving piles in existing railway trestles. For the construction of bridges on new lines, skid, roller and ground hog pile drivers have been in use since railroads were first built. In recent years, the crawler-type crane has come into use quite extensively for driving all sizes of wooden and steel piles and the smaller sizes of concrete piles for bridge, building and dam foundations. Hanging leads are attached to the boom point. Sometimes, to stabilize the leads to control more accurately the direction of the piles as they are driven into the ground, two heavy struts are attached to the bottom of the leads and connected to the revolving frame of the crane. These struts are crossed, in some instances, to provide additional rigidity.

Pile Hammers

The drop hammer has almost lapsed into disuse, being used only on small jobs where the more elaborate and expensive equipment required for steam hammer operation is not justified. Drop hammers are usually operated by means of a wire or manila rope attached to a round pin in the top of the

hammer and are raised by a hoisting drum powered with a steam or internal combustion engine with a friction clutch.

When the hammer is used in connection with a driving cap, as when striking the head of a metal pile directly, its base should be made flat, but if it is to hit the heads of wood piles, the base should be made slightly convex. This will help to keep the pile in line, reduce the strain on the toggles and minimize the effort of the front end crew.

Drop hammers used to drive wood piles for the average run of railway structures should weigh from 3,000 to 4,000 lb. It is better to have a hammer with excess weight for the work contemplated than to use one that is too light, as the fall of the hammer can be regulated as conditions demand.

The drop hammer is of low first cost and does not require a steam hose. It is claimed that it will drive a pile to greater penetration under certain conditions than a steam hammer, while it is easier and less costly to transport.

The steam hammer has been made in this country for about 70 years. Its popularity has increased, particularly during the last 20 years, until now most pile driving is done with this type of pile hammer. The steam hammer permits more piles to be driven in a specified time. Piles may be driven as much as 6 to 11 ft. (depending on the size and make of the hammer), below the bottom of stationary leads, and usually 2 to 3 ft. below the base of rail, thus effecting that much saving in cut off. It causes less damage to the pile head, such as splitting, excessive brooming, etc., and eliminates the splattering of creosote caused by the hammer striking the pile head. The steam hammer enables piles of softer or inferior wood to be used. The head of the pile is held more securely in po-

sition and piles may be driven with greater accuracy, as well as avoiding the labor of toggling and spudding. The steam hammer may be used where head room is insufficient for drop hammer operation. The hammer line will last much longer, and there is considerably less wear and tear to

a high fall, and consequent high velocity of impact, is not nearly so effective as a heavy drop hammer with a low fall and consequent low velocity of impact.

A high velocity of impact allows the hammer to broom the head of the pile instead of driving it into the ground. Irrespective of the number of blows per minute that can be delivered, the velocity at the time of hitting the pile can be so high and the ram so light that the energy of the blow will be entirely absorbed within the pile, and not drive the pile.

What Weight of Ram?

In comparing steam pile hammers of equal total weight, it must be conceded that the one having the heavier ram will drive the more difficult pile under all conditions. There is, however, a limit to the velocity of the ram at the time of impact, which cannot be exceeded and still retain its efficiency. The steam on top of the ram of a double-acting hammer does not increase the weight of the ram. The steam pressure merely increases the velocity of the ram and allows a greater number of blows to be delivered in a given time, but each blow must have enough surplus energy to actually drive the pile. A light ram, like a light drop hammer, with high velocity of impact, will damage the pile head.

In 1927 a railway using a single-acting steam hammer drove some test piles to determine the length of piles required in redriving a pile trestle in Arizona. In subsequent pile driving at this location a double-acting steam hammer, employing a light ram, was employed. The piles ordered for the work proved to be too long, even though driving was continued until 65 per cent of the piles were set on fire from heat generated by the hammer. It required from 35 to 50 min.



A Full-Revolving Railway Track Pile Driver With 80-Ft. Leads

the pile driver than with a drop hammer, with resulting reduction in maintenance cost.

There have been claims and counter-claims as to the comparative merits of the single-acting and double-acting steam hammer. Those who have had experience with a drop hammer will agree that a light drop hammer with

to drive a pile to refusal. The five piles having the largest tip diameter in the lot of 180 piles in the job, were held out and, subsequently, driven in four bents and between other piles with a single-acting steam hammer of comparable size and using a heavy ram. Even under these unfavorable conditions it only required from 20 to 35 min. to drive a pile to a penetration obtained with test piles. Only one of the five piles refused.

Lubrication

In selecting a steam pile hammer, serious consideration must be given to the lubrication system. Some steam hammers not only require refilling of the lubricators in the hammers at frequent intervals, but the job is tedious and hazardous. The oil in the lower receptacle runs out when the driver leads are laid down, which requires refill before pile driving can be resumed. Failure to keep the valve-actuating mechanism, which is enclosed and not visible, well supplied with oil will result in serious damage to these parts. The valve-actuating mechanism is rather intricate and delicate. The various features enumerated materially slow up the work and are a distinct handicap, especially where train schedules are not favorable. In addition, these hammers consume excessive steam.

There are steam pile hammers that require no lubrication for the valve and its actuating mechanism, other than that received from the sight feed lubricator in the steam line, except that a little oil is applied to slide bar wedges, which are easily accessible.

Wood Piles

While extravagant claims have been made by the suppliers of numerous types of bearing piles, the

fact is that each is most effective under conditions favoring its use. Wood, the longest and most widely used materials for piles, still is the most convenient and economical material for friction piles in well timbered regions. The main objections have been that it is short lived, attacked by insects, and is easily destroyed by fire. The species most commonly used are the Southern Pines, Douglas Fir, Lodge Pole Pine, Norway Pine, Ponderosa Pine, Oak, Cedar, Spruce, Tamarack, Western Larch, Cypress, Basswood, Elm, Chestnut, Hemlock and Gum.

When durability need not be considered, as for temporary construction, or for foundations where piles will always be submerged in water (except in salt water infested with teredos or other marine borers) or buried in damp soil to such a depth as to exclude air, any untreated wood pile that will stand driving may be utilized safely.

The majority of the railroads that use wood piles for permanent pile trestles or foundations where cut-offs are above ground water level use piles creosoted by the full-cell process, the treatment varying from straight creosote oil to a 50-50 creosote-petroleum mixture for Southern yellow pine and to a mixture of 45 per cent creosote and 55 per cent petroleum for Douglas Fir, all to refusal.

Green southern yellow pine is preferred by some roads in territories where this wood is used in salt waters; the wood is steamed in the treating cylinders at 20 to 30 lb. pressure for 20 or more hours to remove the sap and pitch; then approximately 24 lb. of creosote per cu. ft. is forced into the timber. The steaming weakens the wood, but this loss in strength is not enough to be prohibitive.

Douglas Fir will not stand steaming and may be treated for marine

use either green by the Boulton process or seasoned in the usual way and using the full cell process, preceded by a heating period or bath in the preservative.

There is a wide difference in the average service life of untreated piles of various species of wood that are exposed to the elements in different localities. A certain species may be very durable in the locality where it grows, whereas, if used in other regions, it may decay completely in a few years. Port Orford Cedar piles have been in service for almost 30 years in localities on the Pacific coast where the soil is always moist without appreciable loss from decay, while if used in desert regions of Southern California and Southern Arizona, where the ground is dry, piles of this species usually fail from decay in six to ten years. The Great Northern reports 12 to 15 years service life from untreated Red Cedar piles on the west coast and from 20 to 30 years on other parts of the system.

The average service life of treated piles depends upon such variables as species of wood, locality in which used, climatic conditions, kind of preservative, treatment process, penetration and retention obtained, the piercing of treated surfaces with sharp-pointed tools in handling, improper treatment, and protection of cut-offs. Service records are not, as yet, sufficiently extensive to indicate what the ultimate life might be for the different species under various conditions of service. Piles used in sea water may have a service life as low as 10 to 15 years in the Gulf, Southern Atlantic and Pacific Coast regions, and twice this life in northern waters.

Land piling usually has a much higher service life than marine piling, and when not mutilated with sharp-

pointed tools and properly protected at cut off, will probably have an average life of 30 years or more. Many creosoted piles in railroad trestle bridges are in sound condition after 35 years' service.

Cost of Piles

The cost of piles, both untreated and treated, varies considerably and depends upon such factors as species of wood, availability, distance transported, off-line haul, kind of treatment, amount of retention, etc. Likewise, the cost of driving varies for different localities and roads, depending on the length of the piles, kind of structure, type of soil, density of traffic, distance from job to siding, type of pile driver (including whether handled under its own power or with work trains), experience of the gang and type of hammer used.

Data obtained from railroads and dealers reflect pile costs ranging from \$0.15 to \$0.40 per lineal foot for untreated piles and from \$0.43 to \$0.66 a lineal foot for treated material. The cost of driving runs from \$0.14 to \$1.25 per lineal foot.

Steel H-Section Piles

Although the use of metal piles in one form or another goes back 65 years, the wide-flange steel H-piling came into use in 1908 and is now used extensively in foundations of buildings, industrial plants, bridge piers, abutments and, to some extent, in bents in railroad trestles. In normal times, H-sections in 8-, 10-, 12- and 14-in. sizes, and in different weights, are readily available up to 100 ft. long.

Several types of attachments are used to increase the bearing capacity of H-section piles, the simplest of which consists of steel plates with suitable stiffeners welded between the

pile flanges. Short H-sections as lagging may be attached to the outside of the pile flanges, either at the bottom, or at a suitable distance above the lower end of the piles. In other cases, steel plates are welded on each side of the web at the bottom end of the piles to increase the bearing area. Steel H-piling can be used to good advantage where extreme penetration is required to drive piles in hard material such as shale or on rock.

The bottom end of the pile should not be pointed, as the square end provides a larger bearing area and does not retard driving. In fact, it prevents shifting or creeping of the pile when obstructions are encountered. Steel H-piles are able to penetrate ground containing boulders of reasonable size, submerged timber and other obstructions with little if any damage, and without throwing the pile out of alignment seriously or otherwise impairing its usefulness as a bearing member.

When exposed to the elements, and more particularly in coastal regions, steel H-piling is subject to corrosion. However, investigations conducted in various parts of this country and in Europe indicate that the impairment actually resulting from this cause has been overestimated. Corrosion usually is greatest near the ground line and is practically negligible a short distance below the surface. Many users encase H-piles in concrete a few feet above and below the ground level to keep out corrosion.

Steel H-piles have great ability to withstand long-continued hard driving. If the job requires H-piles longer than can be driven in a single length, they can be extended by splicing on an additional section. If piles are restrained laterally for their full length in firm soil and driving is moderate, a splice may consist only of a full perimeter butt weld or of web

and flange plates welded or bolted on in the field. It is essential that the ends of the splice bolts do not protrude more than $\frac{1}{4}$ in. beyond the outer nut face to prevent undue strain and shearing of the bolts if they should encounter obstructions.

Splices on unsupported sections of piles should be designed to develop the full sectional strength of the piles. Where bolted splices are used, the ends of the sections should be machined perpendicular with the pile axis and be in full contact. Splices tend to force the ground away from the section above the splice as the projection passes through the soil. In soils that do not come back, this tends to reduce bearing values slightly, due to the reduction in skin friction area. Owing to the large difference in the ratio of the perimeter to the section, the skin frictional area of H-piling is much greater than for other types of piles.

Steel H-piles should not be jetted as the action of the water prevents the formation between the flanges of the compacted earth cores which are of great value in developing the load-carrying capacity of the pile.

The cost of H-piling varies widely, depending on the location, nature of the job, conditions of driving, weight and length of piles and the number to be driven, but in general it will run from \$1.25 per foot for 8-in. 31-lb. piles to \$4 for 14-in. 117-lb. piles.

Concrete Piles

Precast: The precast reinforced concrete pile was introduced in Europe about 1897 and some seven years later it was first used in America. It is now used extensively for various purposes by many North American railroads. It possesses the advantage of not being subject to decay or corrosion and is free from attack by marine borers, but disintegration of the

concrete by the chemical action of sea water, as well as mechanical action in territory having rugged climatic conditions, can be expected and must be met. If the piles are properly designed, their manufacture rigidly controlled, and they are subjected to close and careful inspection, this problem can be minimized. While piles over 100 ft. in length have been used, the length generally ranges from 20 to 60 ft. for those manufactured by railroads. Most commercial firms limit the lengths carried in stock to 20 to 40 ft. Concrete piles are usually octagonal or square and vary from 16 to 24 in. for square piles and from 14 to 24 in. across the faces for octagonal piles; they are made with or without taper; the taper, when used, ranges from a few feet from the tip to the full length of the pile. When acting as a column, a pile without taper should be used; on the other hand it may be desirable that a friction pile have some taper. In general, a large pile cannot be driven so rapidly as a smaller one, but the number required may be sufficiently less to effect a saving in total cost.

The Missouri Pacific, long one of the most extensive users of concrete piles for concrete trestle structures, averaging over 5,000 lin. ft. of bridges a year for a nine-year period, has found that 24-in. octagonal piles are more economical than the 16-in. octagonal pile, formerly used. Three of the larger piles in a bent are entirely adequate, where six of the smaller piles were required before; one pile is driven between the old timber trestle chords and one pile on the outside of each chord; this eliminates the necessity for shifting the old timber chord for pile driving, with consequent saving in maintenance cost during the construction period. It should be added that this also permits higher train speeds while the piles are being driven.

Other railroads have utilized this type of pile for trestle bridges and concrete piers. The Chesapeake and Ohio constructed a double-track pile pier a few years ago in which 36 concrete piles, each 18 in. square and 70 to 75 ft. long, were used. The piles were driven in four rows of nine piles each. In addition to the concrete caps for the bridge seat, three horizontal diaphragms, equally spaced, are used to stiffen the piles in all directions. This type of construction does not require a cofferdam. Some roads purchase piles from commercial plants while others fabricate their own.

It is essential that an unyielding foundation be provided on which to manufacture piles, to preclude any possibility of the concrete being subjected to stresses while it is setting. The use of wood and metal for forms seems about equally divided. For square and octagonal piles, reinforcement, as a rule, consists of eight longitudinal steel bars, varying from $\frac{1}{2}$ in. to $1\frac{1}{4}$ -in.; both round and square bars are used spirally, tied together with heavy wire or hoops of $\frac{1}{4}$ -in. steel.

Corrugated concrete piles are usually reinforced with six longitudinal bars $\frac{5}{8}$ in. and larger, with spiral wrapping of No. 9 wire.

Precast concrete piles generally are cast horizontally and are cured by a cold water spray or by steaming under cover. Piles of long lengths should be provided with multiple pick-up points to prevent setting up excessive stresses, while those of moderate length may be picked up at one end or near the middle.

The cost of precast concrete piles varies according to their size and length, the lowest being \$1.18 and the highest \$3.95, or an average of \$2.15 per lineal foot. The cost of driving varies from \$0.75 to \$3.39, or an average of \$1.78 per lineal foot.

Cast-In-Place, Cased: The cast-in-

place, cased concrete pile is an American product and was first used in Chicago soon after the turn of the century. There are a number of different types, both tapered and without taper. The tapered shells have a metal driving point and are used principally as friction piles, while the tubular shells are used for both friction piles and those acting as columns.

The tapered fluted type of pile shell is formed by the cold rolling process. The fluted design increases the skin frictional area and gives the pile enough stiffness and rigidity to permit driving without a core or mandrel, which, due to the reduced inertia, increases driving speeds and lighter driving equipment may be employed.

The shells are made in lengths ranging from 10 ft. to 115 ft. While 8 in. seems to be the accepted standard tip diameter, points ranging from 6 in. to 16 in. can be furnished. The butt diameter varies from 9.4 in. to 18.1 in. A driving collar is welded to the butt. Although the piles are usually made of 11-gage steel plate, they are also made in 9, 7, 3, and 0 gage; this provides a variety of shells that will generally meet most soil conditions. Standard tapers are one inch in four feet to one inch in seven feet; other tapers can be furnished for special conditions.

In limited head room, a tapered section of suitable length may be driven to ground level, after which an extension can be welded on the pile and the driving resumed. Furthermore, this method or procedure permits the placing of a pile of any length and the cutting off of that pile without the loss of the pile section cut off. The shorter lengths may be nested for shipment by rail. They can be rolled off cars without damage.

While this pile is mostly used for foundations for piers and buildings, it has been utilized also for bents of

railroad bridges. The metal shell has a certain vertical reinforcement value, which in many cases eliminates all reinforcing steel, except dowels at the top of the pile. When necessary, the pile can be readily cut off at the proper elevation with an acetylene torch. Fluted piles cost from \$1.10 to \$1.96 per lineal foot, depending on the gage of metal, f.o.b. fabricator's plant.

Another type of tapered pile, which has been in use about 40 years, is made of a thin metal shell. Two types are known as the standard tapered and step tapered piles. The standard pile has a uniform continuous taper; the shell is made of steel of a thickness suitable for the length and diameter of the pile and ground conditions. The shell is spirally reinforced on the inside for its full length with hard wire of suitable size, generally $\frac{1}{4}$ in. to $\frac{3}{8}$ in. in diameter. It is made in 8-ft. sections up to 40 ft., with a tip of 8 in. and a butt diameter ranging from 16 in. to 23.2 in.

Step-tapered pile shells are made in 8-ft. cylindrical sections, of spirally corrugated metal, usually of 20 to 14 gage thickness; heavier or lighter metals are sometimes used, depending on the characteristics of the soil to be penetrated. The steps are formed by increasing the diameter of each section, usually one inch. Each shell section is provided with a double rim plow ring at the bottom end, to the lower rim of which is welded a short spirally-corrugated inner sleeve to allow the sections to be screw-connected. The tip diameter varies from 8 to $11\frac{1}{8}$ in. and the top diameter from $12\frac{1}{4}$ in. for 16 ft. piles, to $17\frac{1}{4}$ in. for piles 88 ft. long. Lengths up to 115 ft. have been used. The shells of both standard and step-tapered piles are relatively light; they may be nested for shipment and can be rolled off railway cars. A tapered collapsible mandrel is used for driving the standard tapered

shells while a step tapered core is employed for the other pile. Owing to the heavy weight of the cores, a pile driver of rugged construction is required.

While the average cost installed, including the concrete, is about \$2.00 per lineal foot, it may run considerably less on the larger jobs. On the other hand, the cost may be substantially higher for a small job and where other factors are less favorable.

Tubular Cased Piles

Tubular or cylindrical cased piles include a number of different types, such as heavy steel pipe, continuous corrugated metal shell, composite, projectile, button with light steel casing, pedestal, and compressed concrete base section. These types of piles have not been used largely for railway bridge foundations, but have been employed quite extensively for building foundations.

Steel pipe casings are driven with open ends or conical metal points. The pipe is available in lengths of approximately twenty feet. If more than one section is required, the sections are connected with cast steel sleeves of appropriate length, with an external collar. The collar seats as well as the pipe ends are machined to insure a true alignment of the pile and a uniform contact of the metal. Common diameters of pipe or piles range from 10 to 18 in., the wall thickness is usually from $\frac{1}{4}$ to $\frac{1}{2}$ in. In the case of open end piles, the soil is removed by water jets, blowing with compressed air jets or by sand pumping. Steel pipe piles are driven without the use of a mandrel or core. Either type of pipe pile may be made up from short sections, thus requiring little headroom; sections as short as two feet are sometimes used.

Continuous Corrugated Pile: A continuous corrugated pile is formed

by fitting a core having a solid steel point into a heavy steel pipe closed at the bottom; both are driven together into the soil to the required depth; then the core is removed and a corrugated thin metal shell is placed in the steel pipe. The corrugated shell is filled with concrete; the core is then lowered into the steel casing until it rests on the corrugated shell and is secured in that position to prevent the shell from rising with the steel pipe, which is then pulled out of the ground.

Button-Bottom Type: In the button-bottom type, a precast concrete point is placed at the location where the pile is to be driven and a heavy steel tube with a reinforced steel base is placed on the point; after which the procedure is similar to that described for the continuous corrugated pile.

Pedestaled Pile: For the pedestaled pile, the apparatus is identical with that used for forming the continuous corrugated pile, except that after the core is withdrawn, a charge of concrete is deposited in the bottom of the pipe; the core is then replaced and the pipe is pulled up a few feet. The core and the pipe together are driven through the concrete, the core is again withdrawn and a corrugated shell placed in the pipe, after which the operation is the same as previously described for continuous corrugated pile.

Compressed Concrete Base Sections: Compressed concrete base sections are formed by driving together a heavy pipe and core as previously outlined for continuous corrugated cased piles. A quantity of concrete is dropped in the casing and the core replaced; the casing is then raised up over the core the desired height; as the concrete is under pressure, it forms a pile shaft at least equal to the outside diameter of the driving casing. From that point the operation is sim-

ilar to that of the pedestaled pile. The compressed concrete base tends to develop the full value of the bearing strata.

Composite Pile: The composite pile consists of a concrete pile superimposed upon a wood pile. The load is carried by the timber section; the top of which must be below permanent ground water level. The concrete section serves as a column. Two methods of placement are most commonly used. One is to proceed as with the continuous corrugated pile; the core is then removed; a wood pile with a properly formed wire wound tenon is inserted in the casing and, by using the core as a follower, the wood pile is driven through the casing until a satisfactory bearing value is developed. The core is then withdrawn and a corrugated steel shell having a reinforcing cage, consisting of vertical bars with hooks, is placed in the casing. The other method is to drive the wood pile to ground level; the corrugated metal shell is then placed over the timber tenon and, with the core in place, the assembly is driven to final penetration; after the core is removed the shell may be filled with concrete.

Projectile Type: The method of forming a projectile pile is similar to that first described for the composite pile, except that a heavy steel pipe with a metal point is substituted for the wood pile. The joint between the upper and lower sections of composite or projectile piles must be so made as to exclude water and mud from the splice at all times, without resorting to pumping or other de-watering devices.

The cost of steel pipe piles ranges from \$1.16 for 10-in. diameter and $\frac{1}{4}$ -in. wall, to \$1.97 for a 12-in. pipe having a wall thickness of $\frac{3}{8}$ in. Spiral welded pipe of 12-in. diameter and No. 7 gage costs from \$0.95 to \$1.20 per foot.

Uncased, Cast-In-Place: Uncased, cast-in-place piles do not have a permanent metal casing; the concrete is in direct and intimate contact with the surrounding earth. Generally the cross section is the same as for cylindrical-cased types. Their use is limited to certain types of soil. The piles are formed in a manner similar to that employed for cylindrical cased types, except, that the concrete is compressed by means of the core and pile hammer resting on the concrete while the casing is being gradually withdrawn. This method of handling precludes concrete arching in the casing.

The cost of uncased concrete piles varies from \$1.20 to \$2.00 per lineal foot for a 14-in. diameter, uniform shaft pile, and correspondingly more for larger sizes; the cost of the compressed pile with mushroom base is \$4 to \$6 higher for the base section.

Water Jet

The water jet is one of the oldest, and under certain conditions, still the most effective of all pile driving methods yet devised. While it may be used in any soil that can be moved with water and will come back around the pile when jetting operations cease, best results are generally obtained in fine sand.

Almost any type of pump that develops sufficient pressure and that will deliver an adequate supply of water will suffice. Although the piston-pattern pump was universally used for this purpose until a few years ago, the trend now is toward the multiple-stage centrifugal pump powered by a gasoline engine. This type of pump is self-contained, and since it weighs only 1,500 to 4,200 lb., it is easily installed. Standard sizes, ranging from one to four stages with capacities up to 300 gal. per min., and developing water pressures of 75 to 300 lb. per sq. in. and powered by four

to six-cylinder gasoline engines, are now offered. This equipment is mounted on steel skids or trucks. The size of the jet pipe generally varies from 2 to 4 in. nozzleed to proper size at the lower end. Sometimes jet pipes of smaller sizes are used. Combinations of air and water jets are also sometimes used with good results. In some soils, one jet will do the work, while in other cases, two and even three may be necessary.

When only one jet is used, it should be shifted from one side of the pile to the opposite side as often as may be required to maintain the pile in proper position as it sinks into the ground. The jet pipe should be hung to a rope passing through a small snatch block attached to the driver leads and kept moving up and down or gradually lowered, depending on soil conditions. This may be done by hand, or mechanically with a winch head, but not from a hoisting drum. The jet nozzle is kept near the point of the

pile. It is essential that the jet be kept in motion to prevent its freezing. Also, after the pile reaches a certain depth, the water will sometimes cease to flow around it, coming out on the surface of the ground some distance away and possibly around a pile driven previously. When this happens, the jet must be withdrawn immediately and started down again as quickly as possible to reestablish the stream of water along the pile.

In building falsework to support a railroad track during the construction of a combination grade separation and river bridge in Los Angeles, Cal., it was necessary to sink wood piles to depths of 30 to 40 ft. through hard packed gravel strewn with boulders 12 in. or more in size. The piles were placed by the use of a water jet and steam pile hammer. The jetting equipment consisted of a four-stage centrifugal pump driven by a six-cylinder gasoline engine, transmission connected. The pump delivered 300 gal. of water per minute at a pressure of 275 lb. per sq. in. A 3-in. jet pipe, nozzleed to 1¼ in. was used. Water was obtained from the city main through a special connection. After some experimenting, best results were obtained by first working the jet down its full length into the ground, allowing the water to flow for a short time. The jet was then withdrawn quickly; the pile placed in the leads and driving commenced at once. In some cases the pile was driven home without further jetting. In quicksand, this procedure has proven very effective.

Preboring

Experience clearly indicates that inability to obtain the desired pile penetration, in large measure, is due to using steam pile hammers of improper design and too light for the job requirements.



When Preboring Is Required, "The Work Can Best Be Done With a Power-Driven Earth Augur"

Regardless of the size and type of hammer that may be employed, there is a limit to the depth that piles can be driven and, if sufficient penetration can not be obtained, some other means of sinking the piles must be introduced. In many cases the only alternative is to preform holes for the piles. Although various methods have been employed, the work can be best done with a power-driven earth auger.

Post hole augers have been used to a limited extent for preboring work, but they are too slow and should be confined to jobs that are not large enough to justify more costly equipment.

DISCUSSION

President Dove: Only after the tentative draft of this report had been submitted and passed on by the Subjects committee was it realized that it was, of necessity, quite long. It was impossible to confine the report to a limited number of words, but Mr. Martens has handled it unusually well.

The meeting is now open for discussion and I will start by asking Mr. Martens to explain continuous corrugated pile to me. You say, "A continuous corrugated pile is formed by fitting a core having a solid steel point into a heavy steel pipe closed at the bottom; both are driven together into the soil to the required depth; then the core is removed. . . ." I do not understand this.

Chairman Martens: The steel pipe, which, of necessity, must be of heavy section to compress the soil, is driven first. The core is then removed, after which the corrugated metal shell is inserted.

President Dove: Why have the core in there in the first place?

Chairman Martens: It is used to keep the bottom from coming up into the drive pipe.

President Dove: You say it is supposed to be closed at the bottom?

Chairman Martens: The closed bottom consists of light flat metal plate, on which the point of the core rests during driving operations. This plate prevents mud, etc., from entering the bottom of the drive pipe when the core is withdrawn. The core has a cap which fits snugly over and around the top of the drive pipe to prevent undue damage to the latter. Quite elaborate equipment is required for the placement of this type pile.

G. S. Crites (B. & O.): Not only the Bridge and Building Association, but the engineering profession in general, should be indebted to this committee for this report.

For a long time, the A.S.C.E. Proceedings have contained lengthy and tortuous discussions on pile driving formulas. The A.R.E.A. also has been working on pile formulas, and I believe this year came to about the same conclusion as Mr. Martens and his committee. The committee is, indeed, to be congratulated upon presenting such a fine report before this association.

Lodgepole Piles

A. R. Harris (C. & N. W.): Mr. Martens, you mentioned lodgepole pine as one species of wood suitable for piling. I should like to know whether you actually use this material on the Santa Fe. It is of light density, and I should like to know whether it will stand up under driving.

Chairman Martens: To my knowledge, this material has not been used for piles on the Santa Fe. The information the committee received on this timber came from another source. The Santa Fe uses Douglas fir and Southern pines. There are a number of species of the latter, and it requires a good knowledge of the characteristics of each to distinguish Southern long-leaf from the more inferior species, such as short-leaf and Loblolly. Years ago, the Santa Fe used considerable Port Orford cedar, as well as some red cedar.

Mr. Harris: The reason I asked about this is because it was offered for use on the Chicago and North Western, and the question came up whether it was suitable, and, if so, for what kinds of work.

Chairman Martens: While this species is moderately low in strength, it can be used, untreated, for falsework; also in places where it will always be submerged, provided the right kind of driving equipment is used. Untreated, it is not durable, but the sapwood can be readily treated with creosote.

A. M. Knowles (Erie): Mention is made in the report of corrugated concrete piles. As this was new to me, I am wondering why corrugated concrete piles, rather than any other type.

Chairman Martens: I had anticipated that that type of pile would be questioned from the floor. The term is misleading. Actually, this pile is fluted, similar to the fluted metal pile on the market, to increase its frictional bearing area. However, the producers list it as a corrugated pile. There are not many of them in use.

Overdriving Piles

R. E. Caudle (M. P.): This report is quite complete. It presents a large amount of worthwhile information for association members, as well as for others who may have access to it.

Mr. Martens, have you had any experience with the over-driving of creosoted piles? Several years ago we had a failure of creosoted piling after only about 12 years of service. Two bridges had been driven within a short distance of each other. The first notice I had that one of these bridges was failing came when the batter piles showed decay inside the treatment. The other bridge was inspected, but no decay showed in the piles. They were treated at about the same time, and were driven at the same time.

I made a thorough investigation of the matter and found that the regular pile driver foreman drove the bridge on which no decay was showing. He was then involved in an accident and the assistant foreman drove the bridge on which decay was developing. The driving report revealed that the regular foreman had driven the piles for about 12 or 14 min. with a steam hammer and had quit with about 30 to 32 blows to the foot. The other foreman had stayed on the piles as long as 35 and 40 min. Two hundred and fifty to 300 blows were delivered to the piles after they quit going down. My conclusion is that the piling was overdriven, and that after the piles stopped going down, the continuous blows of the hammer caused the fibres to open, bringing about small longitudinal cracks in the piles. The reason these batter piles

went bad more quickly than the others was that the water leached the creosote out of the cracks and started decay on the untreated heart portion. One of the bridges is still in good condition after 21 years, while the other bridge was redriven after 12 years.

It is my thought that it might be well to mention the fact that a pile may be over-driven as well as under-driven, and that precautions should be taken against splitting the pile longitudinally by over-driving.

Chairman Martens: Indeed, piles can be over-driven, but before I can discuss Mr. Caudle's problem intelligently, I would like to know the type of soil involved, and also the kind of timber used, as much depends on these factors.

Mr. Caudle: The timber was short-leaf pine. The soil was clay-loam at one bridge. The other bridge had considerably more penetration, but in the case of the bridge in which the piling failed, the penetration was about 12 or 17 ft. and the piling probably landed on pack sand.

Cause of Overdriving

Chairman Martens: Probably the bottom was a hard formation, such as pack sand or rock. My experience with over-driving indicates clearly that about 85 per cent of it is due to the use of inferior timber for piles; also, through the use of a hammer which is too heavy for the type of timber used, and operated at or above its rated speed, thus developing not less than its full energy rating. A certain steam hammer being operated at its normal speed of 120 blows per minute will develop

15,100 ft.-lb. energy; if this hammer is slowed down to 100 blows per minute, its energy will be reduced to 10,000 ft.-lb. Over-driving can be further alleviated by having an experienced pile driver foreman handle the driving of inferior timber piles in difficult ground. Your chairman has had considerable experience with removing piles in connection with excavation work, some of the piles having been driven 40 years or more, and others only a few weeks before they were removed. Many of these piles were driven, under my supervision, until there was no noticeable movement of the pile for as much as 20 min., after which the pile would again start to move and considerable additional penetration would be obtained before the pile again refused to move. The latter action, as a rule, is indicative of over-driving, yet when these piles were subsequently removed, there was no evidence of such failure.

I have seen serious cases of the over-driving of falsework piles, but this was due to the use of Ponderosa pine, which is also known as Western yellow pine, and grows all the way from Western South Dakota to Washington, and as far south as Arizona, Southern California and New Mexico. This species should not be used for piles, except in soil that is readily penetrated. Even then, great care must be exercised in driving, or trouble may be expected.

Loblolly Pine Piles

H. M. Church (C. & O.): Did I understand you correctly as basing the quality and length of service of piles on the timber species? You

emphasized the quality of long-leaf pine, and then I thought I understood you to say that one could expect premature failure from many of the short-leaf pine timbers. Will not the regular run of Southern pines, including Loblolly and the Southern short-leaf pine, having a reasonable amount of density, be suitable for piles?

Chairman Martens: I believe that Loblolly pine, if it has a reasonable density, is suitable for piles, but we get a considerable amount of Loblolly piles that are not dense; in fact, many are quite coarse. I used about three carloads of such piles two years ago for falsework, and though the driving conditions were moderate, it was necessary to slow up the hammer at times; otherwise these piles would break. However, I have not seen any report of this type of pile failing if it is not abused in driving. Of course, the Southern long-leaf yellow pine pile will take much more punishment, and is preferable for soils that are difficult to penetrate.

Mr. Church: From what you say then, we are perfectly safe in following standard specifications which are based on close grain and, in some instances, density. To my mind, the long-leaf species is almost out of the question for falsework.

Chairman Martens: Investigations conducted by your committee indicate that the supply of the long-leaf species is diminishing. While a large part of the original stand of Southern yellow pines has been cut, the amount remaining, coupled with the ease of reproduction and its rapid growth, will undoubtedly assure an adequate supply of piles for a long time.

I do not want you to get the wrong impression about the various species of Southern pine piles. All will serve well as piles, if they can be driven without being broken. Some species, due to their large amount of sap wood, will take cresote treatment more readily than others, which is desirable. A pile having three inches of sap wood has a much greater treated cross-sectional area than a pile having only one inch of sap wood, and, therefore, is less subject to failure from decay.

Mr. Church: From my observation of the use of short-leaf pine piles with close grain, we prefer the maximum amount of sap wood. With a large amount of sap wood and reasonable care in treatment, we get nearly 85 per cent penetration of the pile.

Hammer Speed

G. A. Linn (C. & N. W.): I have found that the cause of many pile failures is traceable to excessive speed of the hammer at the time the pile reached the point of near refusal. It has been my experience that by cutting down the speed of the hammer with the throttle valve, keeping the speed of the hammer within its rating, that more penetration can be secured with less damage to the pile.

We have a 6600-lb., 24-in. stroke, double-acting steam hammer, rated at 80 to 110 blows per minute, in one of the pile drivers with which I have had considerable experience. This hammer, if not kept under control, will increase its speed to as many as 130 blows per minute when the pile reaches the point of near refusal. When hard driving is encountered, I reduce

the speed to 90 blows, at which speed good penetration is secured, with no appreciable damage to the pile.

When piles reach the point of near refusal, they should be watched closely. If there is any indication of the hammer bouncing, or that the energy of the blow is being dissipated in bending or kicking out of the pile, the speed of the hammer should be reduced or the driving stopped, to prevent damage to the pile.

Chairman Martens: What is the energy rating of your hammer at 125 blows per minute?

Mr. Linn: I cannot tell you.

Chairman Martens: When you reduce the speed of the hammer to 90 blows, what is the energy in foot-pounds?

Mr. Linn: The work done per blow is 9,650 ft.-lb. at rated speed.

Chairman Martens: You get better penetration because the timber will not stand the full blow of the type hammer you are using, and slowing up the hammer permits driving the piles without breakage. But what is the bearing value of the piles? This is very important where pile penetration is shallow in streams, where soils go into suspension as deep as 18 or 20 ft. during floods, as is the case in many locations in the western part of the United States. Here, while a bridge may appear perfectly safe to a person patrolling track, the piles may have been weakened sufficiently to permit the structure to fail under the weight of an engine. While it is to be regretted, it is nevertheless a fact that many practical men have not given enough study to

this phase of pile driving.

I know of piles which were driven to absolute refusal for trestle bridges on new lines, settling badly suddenly under traffic after having been in service 15 years or more. In these cases, the adobe soil had shrunk away from the piles during long dry spells, permitting subsequent rain water to percolate down along the pile. Mixing with the soil, this acts as a lubricant, which materially reduced the skin friction value of the pile.

Mr. Linn: I have had some experience similar to that. In the southern part of Nebraska, I drove a 25-ft. pile to refusal, getting 20 ft. of penetration. The last 26 in., we hit the pile 260 blows with a 3,000-lb. drop hammer, with an average fall of 15 ft. During a flood, this pile washed out, and we found that the point of the pile was resting in fine sand.

Also, I had a similar experience in South Dakota where I drove 20-ft. piles to refusal and could get only 10 ft. of penetration. A 6600-lb. steam hammer was used and we stayed on the piles until we set their heads on fire. Test borings showed fine dry sand well below the points where piles had stopped.

Preforming Holes

Chairman Martens: A steam hammer having a heavy ram compared to the total weight of the hammer would, no doubt, give better results. However, you had a difficult condition, and, in such cases, it is suggested that you resort to preforming holes for the piles or to jetting. Some years ago, before modern boring equipment was available, I was confronted

with driving piles through a fill to a minimum depth of 35 ft. for a new bridge in connection with a channel change. Previous pile driving experience in that general area indicated that piles could not be driven to exceed 15 ft. below base of rail. It was decided to drive a temporary trestle and then excavate for the channel. After the excavation work was completed, holes for the permanent piles were preformed by the use of high explosives. First, a hole $1\frac{1}{2}$ in. in diameter was sunk with an earth auger for the pile located nearest the center line of track in each bent. These were put down to a depth of 18 ft. The holes were then loaded with 40 per cent gelatin and sprung. This provided holes of sufficient size to permit driving piles to the required penetration with ease. Although, after the first pile in each bent had been driven, the adjacent holes were only 2 ft. 8 in. away, none of the piles were injured by blasting operations.

Protecting Tops of Piles

J. S. Hancock (D. T. & I.): We have had serious trouble with creosoted piling in the past few years due to decay of the untreated portion of the sapwood. Trestles, which were only 16 years old, have had to be renewed and we are continually cutting out decayed piling, replacing it with posts or bents, as required. The majority of the decayed piling has been yellow pine, treated with approximately 8 lb. retention, 80-20 creosote oil. This 8-lb. treatment was not enough to give sufficient penetration and left a considerable portion of untreated sapwood between the outside treated shell and the heartwood.

Also, there is an occasional evidence of damaged fibre or separation of sapwood from the heartwood caused by over-driving, which would hasten such decay. At the time this piling was driven, the tops were not protected, except that they may have been given a coat of hot creosote. In most cases, decay started at the pile top in the untreated portion of the sapwood, and, in severe cases, extended down to or a little below the ground line.

We now give piling a 12-lb., 80-20 creosote-oil treatment and protect the pile tops with two coats of Grade 1 creosote applied hot, over which is applied a fibrated tar-base roof cement, into which sheet metal, sheet lead, roofing paper or two-ply fabric waterproofing is placed. However, the purpose of our pile protection is defeated to some extent by driving the cap-to-pile drift through the pile top protection. Our present treating specifications require that 85 per cent of the sapwood in the piling be treated. However, even with better creosoting and protection of the pile tops, I believe the untreated and lightly treated part of the piling will be subject to decay unless the usual drift bolt is eliminated and, possibly, a better pile top protection is developed.

In the case of pile dock construction, the metal pile top protection has been reported as condensing and confining moisture at this location, accelerating, rather than retarding decay.

Our experience has been that roofing paper and cotton fabric have too short a life to make an entirely satisfactory protection. In my opinion, sheet metal protection may have a tendency to condense

and confine moisture at the pile top similar to that reported on pile dock construction, although this tendency on dock construction would be more severe than in the average type pile trestle.

It is entirely possible to damage pine piling by over-driving to the extent that the sapwood is loosened from the heartwood, even to the extent of driving the heartwood entirely through the sapwood shell. The resistance to driving is largely due to skin friction against the outer shell or sapwood of the piling. If the top of the piling is shaped so the blows of the hammer are taken entirely by the heartwood, there is this tendency to shear the heartwood loose from the sapwood. The hammer or follower should be so designed that the hammer blows are distributed to the heartwood and to as great an area of sapwood as possible.

G. H. Holmes (M. P.): We do not use drift bolts to fasten caps to piles. Instead of the drift bolt, we use anchor angle size L 3 in. by $2\frac{1}{2}$ in. by $\frac{3}{8}$ in. by 1 ft. 3 in., with $\frac{3}{4}$ in. bolt through cap and piling. In my opinion, most of the decay in treated piling is caused by the drift bolt, and by improper treatment and sealing of pile heads after cut off is made.

Mr. Church: We still use the drift bolt and we probably have the average condition mentioned of the 85 per cent penetration of the sap. I think that decay of the top of the pile depends entirely on the kind of bituminous cover put over the top at the cut-off. We have been using a roofing paper to supplement the top treatment. A very effective top treatment is to put a mud seam around the pile, or just a little metal cap, about an inch

thick, so you can pour creosote there and allow two or three absorptions of about an inch of creosote to go down into the pile head before you seal it up with hot pitch or tar, and put the roofing paper over it.

The roofing paper has an additional advantage, as the load from the cap on the top of the pile will embed the fibres of the felt—and it is not necessary that you use tar-saturated felt.

Mr. Linn: When renewing caps at various bridges, I have observed the condition of the tops of the piles very closely, and where roofing paper has been used in addition to the brush treatment of hot creosote oil, I have found very little decay. The impact had forced the paper into the fibre of the wood and around the drift, sealing the tops of the piles against moisture. Where roofing paper had not been used, considerable decay was found in the tops of some of the piling. Most of the decay was centered around the drift bolt and was, no doubt, caused by moisture filtering down around the drift and into the top of the pile.

A. M. Knowles: Mention is made in the last part of the report about piles driven in Los Angeles through hard-packed gravel strewn with boulders. I wonder what the object was of going through that hard material.

Chairman Martens: The object was to get the falsework piles below the foundation excavations.

A. M. Knowles: That is sufficient reason.

President Dove: Gentlemen, I believe this completes the discussion on a very fine report and we will dismiss the committee with the thanks of the association.

The Cleaning of Masonry Buildings

Report of Committee

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W. A. Huckstep
Chairman

A building is essentially only a shelter to protect operations from the weather and to furnish storage space for the necessary tools, other equipment and records made necessary by the operation involved. There are many types of buildings used

for a wide variety of purposes, but in the last analysis they are only shelters which make the operations possible and permit them to be carried on in an efficient manner. In theory, so long as a building is weathertight and clean enough to permit operations to be carried on, no further requirements should be necessary.

We do, however, live in a complex world and items which, in themselves, would not be considered by a strictly utilitarian efficiency unit (or person) can affect the not-so-efficient fellow workers, other occupants, customers and the general public in a manner which may tend to nullify the operations conducted by cold-blooded effi-

ciency and strict utilitarianism. Just how far these extraneous items should be considered is questionable, but under-stressing or over-stressing them should be avoided.

In dealing with the general public in competition with others in similar lines there is, in most instances, not much difference in the item produced, but there may be a vast difference in how it is done. Operations conducted in clean, cheerful surroundings, both inside and outside a building, usually cost little more than those conducted in indifferent surroundings; however, the effect of clean surroundings on the general public creates good will which has a definite value.

Desirable high-class tenants may put up with the dirty and dingy exterior of their buildings for a while, but sooner or later competition from similar firms located in clean surroundings is going to be felt and the tenants will go to landlords more in touch with the attitude of the general public. In many cases migration from a once first-class business district to another location and the starting of a movement of the business district in a certain direction are due entirely to the fact that the general public prefers clean surroundings. Once a first-class business district has lost its primacy, in most cases nothing will bring it back.

Following are the various methods of cleaning structures of stone, brick, terra cotta, granite, marble, monolithic

concrete, and stucco on tile.

(a) *Sandblasting*—This is the method where particles of sharp sand are blown by a jet of air or water against the surface to be cleaned. Pressures of 700 to 800 lb. per sq. in. may be used in both wet and dry sandblasting, but in building cleaning work with dry sandblasting, 75 to 100 lb. per sq. in. is used most generally.

Producers of high grade building stone, as well as manufacturers of building brick and terra cotta, recommend against the use of sandblasting methods for cleaning surfaces of buildings constructed with such materials. It is conceded that about the only buildings today on which sandblasting may be used without any appreciable deleterious effect are those constructed of rough stone. Sandblasting is definitely injurious to mortar joints and when this method is used, it should be followed by tuckpointing. Steel bridges, steel tanks and other structures which are constructed of steel and iron are cleaned more effectively by sandblasting.

(b) *Acid Washing*—On new brick buildings the surface of the brickwork is customarily gone over with a wire brush, after which a 10 per cent solution of muriatic acid in water is applied by hand, followed by thorough rinsing of the surface with clean water, under pressure, to remove the acid. The purpose of this treatment is to remove stains and discolorations that occur during construction.

Some building cleaning companies employ hydrofluoric acid as a cleansing agent on buildings where excessive carbonization has set up or where there is an unusual amount of discoloration. This acid sets up a very destructive chemical action unless it is thoroughly neutralized and entirely washed off immediately after application.

Where glass, granite, marble, tile,

terra cotta or limestone is found in combination with other building materials which are to be cleaned with hydrofluoric acid, the foregoing must be covered with melted paraffin, brushed on. As an added precaution, the surfaces should be kept wet while working near them. The paraffin should be removed with paper only.

Extreme care is required on the part of workmen applying this acid and rubber gloves, goggles, long handle brushes, etc., must be used to avoid personal injury. Likewise, extra precautions are required to protect pedestrians and adjacent property from injury or damage.

For these reasons hydrofluoric acid washing should never be undertaken by other than persons experienced in its use and even then it is not recommended as more or less deleterious effects are always noted subsequently.

An outstanding producer and fabricator of structural granite recommends two methods for cleaning polished and dressed granite. (1) Spray or sprinkle the surface of the granite with muriatic acid, then brush vigorously with a stiff brush and plenty of water and rinse thoroughly. Particular attention is directed to the fact that with polished surfaces it is important that the acid does not remain on the surface in full strength for more than a few seconds; otherwise the gloss finish will be dulled. (2) Apply non-inflammable, white gasoline in the same manner as directed for muriatic acid. The granite company above referred to is now using this cleansing agent.

(c) *Steam Cleaning*—After several years of experimentation, the so-called steam cleaning process, a new and efficient method for cleaning stonework, has been developed, whereby a very finely divided spray of steam and water is projected against the building at a high velocity.

Entering the minute depressions in the surface, it dissolves or dislodges and carries away grime, soot and other extraneous matter that may have been deposited on the exteriors.

The detrimental effects of both the "sand-blast" and "acid-wash" methods employed by the average commercial contractor are well known. Sand-blast tends to dull the sharp arrises and blur the ornamental detail and carving, and invariably roughens the surface, cutting through the pro-

oped and now in commercial use by reliable cleaning concerns in many parts of the United States, is far superior to the "sand-blast" and "acid-wash" methods and is more economical and dependable. While the process has been developed primarily for cleaning limestone buildings, it is now employed quite generally for cleaning brickwork, terra cotta, granite and sandstone.

After cleaning by this process, an old stone building invariably presents



Dilute Muriatic Acid, Followed by Washing With Hot Water and Steam Removed a Heavy Incrustation of Dirt and Soot from this Building

TECTIVE skin and thus opening the pores and thereby destroying to a great extent the well-known grime-resisting and self-cleansing properties of limestone. Acid-wash, besides having a tendency to eat into and pit the stone, usually exerts a bleaching action, causing the stone to present an unnatural appearance and sometimes causing it to turn a yellow color later on. Furthermore, when the acid solution is not thoroughly washed away, the destructive chemical action that may result, due to the chemical left in the pores of the stone, will often continue for some time, even years, after the cleaning is done.

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Suitable for New Stone

This method of cleaning is suitable not only for old buildings but also for cleaning down new stonework. New stone cleaned with steam usually has a greater apparent range of color-tone and texture than when cleaned by

hand because of the greater effectiveness of the steam jet and water in removing from the pores of the stone the stone dust and dirt which accumulate during the cutting and setting of the stone.

The following rates per nozzle have been reported, with steam at about 150 lb. per sq. in. The commercial cleaning rate usually runs from 5 cents to 10 cents per sq. ft. of surface cleaned.

Building in Boston, Mass.

1500 sq. ft. per 9-hr. day for new work.

1000 sq. ft. per 9-hr. day for old work.

Building in Bedford, Ind.

Cleaned directly after completion—

2400 sq. ft. per 8-hr. day.

Building in Bedford, Ind.

Original building 15 years old—addition 3 years old—no discernable difference between old and new stonework after cleaning—1000 sq. ft. per 8-hr. day.

Building in Washington, D.C. (marble and brick)

11 stories high and several years old.

Two nozzle-men working together, each nozzle-man cleaning 1000 sq. ft. per 8-hr. day.

For steam cleaning of limestone buildings the procedure recommended is as follows:

Steam should be generated in sufficient quantity to maintain the pressure required. A pressure of at least 140 lb., preferably 150 lb., per sq. in. is required for old and dirty buildings, although 100 to 120 lb. is usually sufficient for cleaning new buildings.

Steam and water are brought to the nozzle in separate hose, usually $\frac{1}{2}$ in. in diameter. The relative amounts of steam and water are controlled by quick-acting valves at the nozzle. Only sufficient water pressure is needed to carry the water to the nozzle, the velocity of the spray being imparted entirely by the steam.

The steam cleaning process, using high pressure steam and water, is

rapid, practical and economical and does not injure limestone, sandstone, brick or terra cotta. No dust, dirt or chemical is left on the surface or in the pores of the stone to cause unsightly streaking of the building later during rainy weather.

High pressure steam or water vapor (140-150 lb. per sq. in.) should be used for cleaning old, dirty stonework, although new work may be cleaned with the ordinary boiler pressure of 100 to 120 lb.

(d) *Water Vapor Cleaning*—This is a method which employs the delivery of a substantial volume of vaporized water under high temperature from a nozzle giving a broad, knife edged, high velocity jet, with pressure sufficient to penetrate minute crevices and carvings to dislodge, dissolve and completely carry away alkali, acid, soot, etc. The nozzle is held a few inches from the surface and, starting at the operator's shoulder height, is moved in a horizontal sweeping motion, working down. Only clear water is used and it must be softened with water-softening compound.

The equipment used for vapor cleaning can likewise be used in applying mild acid, alkali and soap solutions where their use is desirable. This method consists of three operations:—pre-soaking thoroughly with water, or preferably with vapor; the application of the chemical solution of the desired strength, following the same procedure as for cleaning with vapor only; the rinsing of the surface again, using the same procedure as for cleaning with vapor. In switching from solutions to vapor, sufficient time must be allowed for the machine to clear itself (usually about three minutes). The rinsing of a section can be followed immediately by the pre-soaking of the next section, which gives a continuous operation.

Where it is desired to combine va-

por cleaning with hand application of chemical compounds, the method also consists of three operations; pre-soaking thoroughly both the section being cleaned and the adjacent area with water or preferably with vapor; the application of chemical by a suitable hand method (usually a brush); the thorough rinsing of the surface, following the same procedure as in cleaning with vapor only.

Chemicals: Where chemicals are to be used in conjunction with either steam or vapor cleaning, the first consideration is that they shall in no way affect or disintegrate the surface to which they are applied. The speed with which excess grease or dirt reacts to a chemical must be a secondary consideration.

Soap: For hand application up to 5 lb. to 5 gal. of water. For machine application up to 5 lb. to 50 gal. of water.

Provision should be made for overcoming the hardness of the water by using a water softening compound.

Cleaning Compounds—A number of manufacturers make chemical compounds for specific cleaning purposes and the kind to be used must be determined from the cleaning work to be done. Manufacturers provide instructions for their use.

Acid Cleaning

Acids—The following acids will meet nearly all requirements.

Oxalic—Mild oxalic acid does not attack glass or metal to any extent. Used also for neutralizing salt efflorescence. For application by hand, use 1 lb. of Oxalic acid crystals to six gallons of water. For vapor machine application, use up to 6 lb. for 50 gal. of water. Use no water softener when adding acid to a vapor machine solution tank for applying the solution from the machine, but for rinsing,

soften the water in the regular manner.

Muriatic—Stronger, more powerful than Oxalic. Does not materially affect glass, works a little on mortar. Has a tendency to discolor light colored brick. For hand application, use 1 to 2 gal. to 10 gal. of water. Rubber gloves should be worn. For machine application, use 1 to 3 gal. to 50 gal. of water. Use no water softener when adding acid to the solution tank, but for rinsing, soften the water in the usual manner.

Hydrofluoric—Readily attacks silica and glass; therefore, all glass must have a protective covering, preferably of grease or paraffin. Very small areas should be cleaned at a time so that the acid does not begin to dry out before it is thoroughly rinsed. *This acid can be applied by hand only.* The safety precautions already given under the heading "Acid Washing" should be carefully observed. Solution strength, one-half to one pint of commercial acid to five gal. of water. The use of this acid is not recommended except in extreme cases.

Types of Surfaces

Brick—Yellow, buff and all light-colored press brick may be cleaned with steam or vapor only, or cleaning compounds. Tapestry, ruffles and red common brick may be cleaned with a cleaning compound in conjunction with steam or vapor. Glazed brick may be cleaned with soap or a cleaning compound if a cleaning agent is desirable. Never use hydrofluoric acid.

Terra Cotta—Glazed or unglazed. May be cleaned with steam or vapor only; cleaning compound or soap. Never use hydrofluoric acid.

Granite—Refer to portion of report under caption of "Acid Washing."

Marble—May be cleaned with steam or vapor only; soap or cleaning compound.

Removal of Stains

Following are some methods recommended for the removal of various types of stains from masonry:

Paint Stains:—For fresh paint, apply a commercial paint remover, or a solution of tri-sodium phosphate in water—2 lb. of tri-sodium phosphate to 1 gal. of water. Allow to stand and remove paint with a scraper or wire brush. Wash with clear water. For old, dried paint organic solvents similar to the above may not be effective, in which case it must be ground off by sand blasting or scrubbing with steel wool, provided, of course, that the texture of the masonry surface is such that the possible injury thereto by this treatment will be compensated by the results gained.

Smoke Stains:—Make a smooth, stiff paste of trichlorethylene and powdered talc and apply to the stain with a trowel. Scrape off when dried and repeat until the stain has disappeared, then wash thoroughly with clean water. Keep covered to prevent rapid evaporation. If a slight stain is left after several applications, wash thoroughly with the following:

Dissolve 2 lb. of tri-sodium phosphate in 5 qt. of water. In a separate vessel make a smooth, stiff paste of 12 oz. of chloride of lime in water. Pour the former onto the paste and stir thoroughly. When the lime has settled, draw off the clear liquid and dilute with equal parts of water. Make a stiff paste of this with powdered talc and apply in the same manner as directed above. Precaution should be taken to ventilate a closed space in which trichlorethylene is used, as the fumes are harmful.

Coal Smoke Stain:—Scrub with

powdered pumice and a wire brush. This is an alternate method to the one given above. Painters Magazine recommends a solution of one gallon of soft soap, two pounds of powdered pumice and one pint of liquid ammonia, beating the mixture well. Apply a fairly thick layer with a fibre brush, allowing it to remain about 20 minutes, then rub it in with a good stiff scrubbing brush, using plenty of elbow grease. Use a large sponge to remove the lather and then rinse with clear water. This, if properly done, will remove the most stubborn case of discoloration by coal smoke.

Oil Stains:—(2 Methods) (1.) Make a paste of a solution of one pound of tri-sodium phosphate to one gallon of water and whiting. Spread this paste in a layer about one-half inch thick over the surface to be cleaned and leave until it dries, approximately 24 hr. Remove the paste and wash surface with clear water. (2.) Saturate a blotter with either amyl acetate or benzene and place it over the stain, making sure that the blotter extends well over the boundaries of the stain. Place a hot iron, or preferably a hot slab of stone, over the blotter. This hastens the evaporation of the solvent and consequently hastens the removal of the stain. Where the stain is hard to remove, the treatment must be repeated.

Tar Stains:—Scrape off all the tar possible with a sharp edged instrument, being careful not to smear the adjoining surface during the operation. After this has been done, follow direction No. 2 for the removal of oil stains, taking care to change blotters after the old one has become saturated with tar. The operation usually has to be repeated several times.

Tobacco Stains:—Dissolve two lb. of tri-sodium phosphate in a gallon of hot water. Mix 12 oz. of chlorinated lime to a paste in a shallow enamel

pan by adding water slowly and mashing lumps. Pour this and the tri-sodium phosphate into a stoneware jar and add water until approximately two gal. are obtained. Stir well, cover the jar and allow the lime to settle. In using this on tobacco stains, add some of the liquid to powdered talc, mix until a thick paste is obtained and apply as a poultice one-fourth inch thick with a trowel. If it is desired to apply this with a brush, add about one teaspoon of sugar to each pound of powdered talc. When dry, scrape off the poultice with a wooden paddle. This mixture is a strong bleaching agent and is corrosive to metals; hence in using it, care should be taken not to drop it on colored fabrics or metal fixtures.

Iron Stains:—Brown cement stain should not be confused with brown stain caused by rusting ironwork simply because they may have a similar color and appearance, as rust stains will only be found where the masonry adjoins rusting ironwork.

The following treatments have each been used successfully for eliminating brown rust stains:

(1.) Scrub with a hot concentrated solution of oxalic acid. The objection to this is that this acid may cause some noticeable etching of the surface of the masonry, but this is not usually very bad because of the formation of an insoluble calcium oxalate film on the surface of the masonry. Where used, it is advisable to follow this application with a thorough drenching with water from a hose.

(2.) Mix seven parts of lime-free glycerine with a solution of one part sodium citrate in six parts of lukewarm water and make it a thick paste with whiting or kieselguhr. Apply the paste to the stain with a trowel and scrape it off when dried out. Repeat until the stain has disappeared, and then wash thoroughly with clean water.

(3.) Iron stains can be removed with sodium hydro-sulphite. As a preliminary treatment, dissolve one quart of sodium citrate in six parts of water and apply this to the stain by saturating white cotton in the solution and placing it over the stain. Leave this on the stain while the materials for the following treatment are being prepared:

If the stained stone is in a horizontal position, sprinkle a thin layer of hydro-sulphite crystals over the stone, moisten with a few drops of water and cover with a thick paste made of whiting and water. If the stain is in a vertical position, place the whiting on a plasterer's trowel, sprinkle a layer of hydro-sulphite crystals on the face, moisten slightly and apply it over the stain. Leave this for one hour and remove. If the stain is not all removed, repeat the operation. When the stain disappears, rinse the surface thoroughly with clear water and make another application of the citrate solution, as in the first operation. The purpose of the sodium citrate treatment is to prevent the reappearance of the stain. Occasionally, in treating iron stains with sodium hydro-sulphite, the original brown stain may change to black. If hydrated lime is used instead of whiting for the poultice, this nearly always occurs. In case a black stain occurs, it should be treated with hydrogen peroxide until it is oxidized back to a brown color; then proceed with the hydro-sulphite treatment as above.

Green Stains: (From copper and bronze)—Such stains are usually found on the bases of bronze statuary or where bronze plates are attached to stone. The stains are nearly always green, but bronze apparently causes brown stains in some cases.

Scrub the stone with a dilute solution of potassium-cyanide containing from one to two ounces of the cyanide

per quart of water, or in lieu of this use a sodium-cyanide solution of the same strength for the scrubbing of stone. This will generally remove such staining completely and leave no apparent bad effects on the surface of the stone. It is advisable to follow this treatment by a thorough drenching of the surface with water from a hose. It should be kept in mind that potassium-cyanide is very poisonous and in that respect is dangerous to use, so operators should be equipped with rubber gloves.

Blood Stains:—Wet the stain with water; then dust over with a thin, even layer of sodium peroxide. Then sprinkle with water. Care must be taken not to breathe any of the peroxide dust or allow it to come in contact with the skin as it is very caustic.

Allow the peroxide to remain a few minutes, then scrub vigorously with copious amounts of water. This removes the stain and it is seldom necessary to repeat the operation. After the sodium peroxide has been washed off, scrub with a ten percent solution of formic acid. The acid wash neutralizes the last alkaline traces left by the sodium peroxide. It is best to see a druggist regarding the dilution of the formic acid.

Brown Stain and Discolorations:—No treatment, so far, has been found successful for the removal of the brown stain due to staining cements when the wall is wet. For this reason, before any treatment is undertaken for its removal, all leaks into the wall must be stopped. Many people prefer not to attempt artificial removal of this stain for, when the wall dries out, natural weathering agencies will usually remove it in a short time, leaving no trace behind.

If the stain covers a large area, clean it off with steam, under approximately one hundred pounds pressure, ejected from a flat nozzle. This is eas-

ily done by simply playing the steam over the stain until it is removed. This treatment must be followed immediately with a scrubbing with a ten percent solution of formic acid.

If small areas are to be treated or if the use of steam is not advisable, the following poultice treatment may be used. Mix paper pulp or some other fibrous material with enough fireclay to give it workability when moistened. An alkaline poultice and an acid poultice are made from this.

Mix part of the semi-dry paper pulp-fireclay mixture with a solution containing 3.8 oz. of sodium carbonate per gallon of water until it can easily be worked under a trowel. Plaster this over the stain, extending it to the edges of the stone that is being treated. After twenty-four hours remove the poultice. Due to the paper mat, it will peel off easily, leaving the stone nice and clean. This is followed immediately with a poultice made from the unused semi-dry paper pulp-fireclay mixture moistened to a working consistency with a ten percent solution of formic acid. This second poultice prevents the immediate recurrence of the stain.

Formic acid may be purchased in varying concentrations and a druggist or a chemical supply house should be seen regarding its dilution.

Steam Equipment

(d) *Machines:*—Several methods have been employed successfully for the production of steam:

An ordinary high pressure steam boiler is perhaps the most common source. A boiler capacity of about 12 hp. per nozzle is required. One company has developed a special oil-fired portable steam plant weighing about 2,000 lb., and costing about \$1,600, exclusive of truck mounting, with a capacity of one large nozzle or two

small ones. Another company manufactures a steam machine weighing about 1,000 lb. in the stationary type, and 1,300 lb. in the portable type, costing \$645 up, depending upon the auxiliary equipment and type of unit purchased. A cleaning unit is now being manufactured by still another company which, in a trailer type, sells



After Cleaning a Structure, All Defective Mortar Joints Should Be Cleaned Out Thoroughly and Tuck-Pointed

for approximately \$1,000; in a portable type for approximately \$850, and in a stationary type for about \$750. There is still another company which produces water vapor machines which are available in several portable, trailer and stationary types.

Tuck-pointing and Caulking

(a) *Mortar, Color, etc.*—After the wall surface has been cleaned, in most cases any defects in the mortar joints will show up very plainly. All defec-

tive mortar joints should be thoroughly cleaned out and pointed up with mortar consisting of proper proportions of well-graded sand, cement and lime putty, with the addition of such coloring matter as may be required to match the color of existing joints. Before proceeding with the tuck-pointing, two or three samples with different amounts of added mortar color should be prepared to obtain the correct color matching.

(b) *Caulking Around Windows:*—It is generally found in buildings that the joints between the window and door frames and the masonry walls will leak air and allow dirt to sift in. These joints should be thoroughly caulked with an elastic non-drying, non-staining compound which can be forced deep into the narrow cracks with a pressure gun. In addition, parapet walls which have copings of stone, terra cotta or pre-cast concrete blocks can be sealed more tightly and effectively with a good caulking compound than if re-pointed. There are several recognized good brands of caulking compound and it is important to exercise care in selecting the brand to be used.

It is inadvisable to say that any one particular method is superior to all others for all cleaning purposes, for each has its specified field. The following methods, given in preferential order as regards their possible deleterious effect upon a building, cover almost any building cleaning which may become necessary:

- Water vapor cleaning
- Steam cleaning
- Acid washing (excluding hydrofluoric acid)
- Sandblasting
- Hydrofluoric acid washing.

The first two methods will, in most cases, be more economical and cause less disturbance of normal operations in and about the premises being

cleaned. Either method can be combined with the use of commercial cleaning solutions and thereby produce satisfactory results in almost all cases except buildings where excessive carbonization has occurred on the masonry surfaces.

So-called bleaching agents, which some building cleaning contractors recommend, have not proven so far to be entirely satisfactory. While they will bleach the masonry surface, this effect is usually maintained for a short time only, after which there is a noticeable yellowing of the surface.

Quite naturally there will be some difference of opinion as to advisability of cleaning railroad buildings with railroad bridge and building forces. There seems to be no substantial reason why masonry buildings cannot be cleaned by bridge and building forces, if they are furnished proper equipment and given complete instructions in the method to be followed. After determining the method which seems most suitable to the particular type of cleaning work to be handled, the necessary portable equipment and appurtenances can then be obtained. Manufacturers furnish complete instructions for the operation of their equipment and usually will furnish an experienced man to give a practical demonstration in its use.

Building cleaning by bridge and building forces, however, has its limitations. All buildings over two, or possibly three stories in height and probably also all buildings located in large cities where reputable building cleaning contractors operate, should be cleaned by contract. In the first instance, it would be expensive to provide additional hoisting cables, hose and other accessories for the higher operations, for the comparatively few instances they would be required. Further, only men who follow building cleaning work as a regular voca-

tion should handle and work from scaffolds at heights of more than two or three stories. In the second instance, building cleaning contractors are generally familiar with local ordinances governing such work in cities and it is possible that local ordinances provide that such work can only be done by licensed contractors.

Eliminating the buildings covered by the preceding paragraph still leaves the bulk of the masonry buildings to be found on most large railroads as a possible field for cleaning operations by bridge and building forces. Undoubtedly a considerable saving can be effected by using these forces for building cleaning operations, particularly where the buildings to be cleaned are remote from cities where reputable contractors are located. The cleaning of railroad buildings, particularly passenger and freight stations, office buildings, etc., is definitely important and the success of doing such work by bridge and building forces depends upon the effort put forth by supervisory officers in obtaining all available information as to methods, use of equipment, cleaning compounds, etc., and seeing that it is received and understood by the foremen who are to execute the work.

Incidentally, the portable type of cleaning equipment referred to earlier in this report is also adapted to the cleaning of gasoline motor cars, trucks, buses and equipment where grease, oil and dirt accumulate, and in pre-cleaning frame buildings before repainting.

Typical Specifications

(Name of Railroad—_____)

Specifications for cleaning exterior walls of (indicate the particular building and its location).

General Conditions

Scope of Work: The work to be done

consists of furnishing all labor, materials and other instrumentalities to clean all exterior (indicate type) surfaces of (indicate what building and its location).

Bond: Contractor will be required to furnish bond from an acceptable corporate surety in approximately the total amount of the bid, conditioned for performing the contractor's undertakings under the contract.

Insurance: Contractor shall obtain workmen's compensation insurance, in legal limits, and Public Liability insurance with limits of \$25,000 for one person and \$50,000 for one accident and shall deliver to the Carrier certified copies of such policies before undertaking any work at the site. (Amounts specified for liability insurance suggestive only and can be varied as may seem desirable).

Sales Tax: Contract price shall cover all of contractor's costs, including any sales or other tax payable by law and no payment additional to the contract price will be made to the contractor on account of such sales or other tax.

Supervision and Permits: Contractor shall keep a competent foreman constantly at the work. Contractor shall obtain all necessary permits relative to the work, paying the legal fees therefor and shall be responsible for the observance of all federal, state and local laws and ordinances governing such work.

Use of Premises: Contractor shall confine his apparatus, storage of materials, and the operation of his workmen to limits indicated by laws, ordinances, permits and as directed by the Carrier's Architect or other designated officer.

Cleaning Up: Contractor shall, during the progress of the work, keep the premises free of any rubbish resulting from his operations and likewise shall leave the premises clean upon completion. After completion of the work the Contractor shall not leave any advertisements or signs, designed to attract public attention, upon any part of the building.

Cleaning Work

Method: The method to be used in cleaning shall be (here indicate the method).

(Where it may be desirable, the following paragraph can also be included under this heading).

The Contractor may, at his option, also submit an alternate bid based on a method of cleaning other than above specified; however, he must clearly specify how he proposes to do the cleaning.

Cleaning Solution: The solution used for cleaning the building must be of such character as to be perfectly harmless to any building material with which it comes in contact.

All bidders must submit with their bids a sample of the cleaning solution they propose to use in order that the Carrier may, before awarding contract, have tests made to determine whether such solutions have any deleterious effect upon the masonry or its bonding mortar.

The Contractor shall supply, when requested by the (Architect), samples of cleaning solution used during the progress of the work, for comparison with the sample submitted with his bid.

Protection of Building: Immediately before any cleaning solution is applied, the surfaces to be cleaned must be thoroughly wetted with clean water to prevent the solution from penetrating the masonry and mortar and subsequently leaching out and causing stains and discolorations.

Contractor shall take necessary precautions to protect all windows, doors, metalwork, roofings and other parts of the building from damage from the cleaning solutions or his operations. Any damage that results from the cleaning solutions or Contractor's operations shall be repaired at Contractor's sole cost.

The cleaning solution must be thoroughly rinsed off with an ample supply of water to avoid possible future damage to the surface of the masonry, mortar, roofing, or any other portion of the building.

Contractor shall keep the cleaning solution constantly flushed off all roofs as may be directed by the Carrier's (Architect).

Contractor shall not place any part of any boom, scaffolding apparatus, or other equipment against roof flashings

or upon roofing until approval of Carrier's (Architect) has been obtained for the manner in which it is proposed to protect the roofing from damage. Contractor shall not place anything upon any roof which might cause damage to the roofing without first taking proper precaution against possible damage.

Protection of Public and Building Occupants: Contractor shall provide, at all times, canopies of approved type over sidewalks or platforms adjacent to the building for the entire length of the building on the side where washing operations are in progress, for the protection of the general public and building occupants. Canopies shall be of sufficient width to fully protect pedestrians and to protect entrances to the building. Contractor shall be responsible for settlement of any claims arising as result of any injury sustained by persons or damage to property consequent to the performance of his work, however caused.

Method of Procedure: The operation must be started on one side of the building and be continued on the same elevation until the entire side is completed. The work must be carried out with the greatest possible rapidity to avoid inconvenience to building occupants, as well as the general public.

Water for Cleaning: Carrier, without cost to the Contractor, will provide at the existing hydrants on the premises the necessary water required for the work at an initial pressure of not less than—lbs. gage.

The foregoing is the complete specification for cleaning exterior of—

(Architect)

Office of—

(Location)—

(Date)—

DISCUSSION

President Dove: Mr. Huckstep and his committee have submitted a very thorough report. I know that many of you have plans for this work. The subject was becoming more and more alive until the beginning of hostilities on December 7, after which, other things engaged our attention. Before opening the meeting to discussion, I want to caution you that we do not like to have any specific brands or manufacturers' products mentioned in the discussion, if it is possible to avoid it, for fear that the association might be charged with being biased in favor of a particular product. So please endeavor to make your remarks of a general nature when you are referring to proprietary materials. I will now open the meeting for discussion.

Chairman Huckstep: Kieselguhr, referred to in the report, was formerly known as white mud until they determined what it was. It is composed of diatoms, which are microscopic unicellular organisms. They are found in both fresh and salt water, and when they die, their skeletons accumulate and, when dried, form a very fine white powder. This has a fine polishing effect upon stone or any sort of smooth masonry. It has a tendency to make it white, so if you can get kieselguhr instead of whiting, it is to be preferred.

One of the committee members, in submitting a tentative draft, listed certain types of caulking compounds. While we cannot mention names or brands, I do want to say to you—what many of you probably know already—that

caulking compounds are comparable to sand or cement, and there is a lot of difference in what various types and grades will do. Before using a compound, I would suggest that you ascertain which are the valuable ones, and will do the work you have to do.

L. G. Byrd (M. P.): There is one question I would like to ask. The report states that one company manufactures a portable steam machine weighing about 1,300 lb. and a stationary type weighing about 1,000 lb. I wonder how these machines function; what means are used to heat the steam; is it

by oil or gasoline, or by some stationary boiler which furnishes the steam?

Chairman Huckstep: This is standard equipment. It is well known. Probably some roads already have some of it. I know they use it as well for purposes other than building cleaning. All this equipment is oil-burning.

President Dove: Mr. Huckstep, your committee has done such a fine job that there seems to be very little left for discussion. Therefore, I will dismiss this committee with the thanks of the association.



Possibilities for Reclamation and Salvage

By R. P. Hart

Bridge Engineer, Missouri Pacific
(Introduced by President R. E. Dove)



R. P. Hart

President

Dove: Second only in importance today to the ability to secure new materials is the ability to reclaim and salvage materials already on the railways. In a time when the

collection of scrap becomes of pressing national importance, it is natural that the public and the steel mills should look to the railways for assistance, since the railways are the largest producers of

scrap in normal times. Spurred on by the national emergency which has arisen, many railways have inaugurated new and greatly intensified searches for scrap on their properties, in the course of which they have found materials in unexpected quantities and in unexpected places.

One of the railways that has been particularly active in this campaign is the Missouri Pacific. The ramifications of the search on this road extended into every nook and corner of the bridge, building and water service departments. R. P. Hart, bridge engineer of the Missouri Pacific, is going to tell us of this search. Mr. Hart.

Mr. Hart's Address

Much is being said and done at this time about those critical materials necessary to the all-out war effort of our country, and we have been prompted to consider many substitute materials. Until the material situation has been relieved, it will be necessary for us to keep constantly before us the possibilities of reclamation and salvage in order to secure those materials required to maintain our bridges, buildings and water service facilities. My purpose here is to bring to your attention some of the

things that have been done on the Missouri Pacific in this direction, with the thought that they may be helpful and suggestive to you in solving your own material problems.

All of us on the Missouri Pacific are taking the war very much to heart. Everyone, from the head of our system down to the newest messenger boy, is intent on doing everything that will speed up the war effort. Under the leadership of L. W. Baldwin, our president, we are constantly impressed with

the fact that the part the railroads have to play in bringing about victory is a very great and grave one. We realize that adequate transportation will not, of itself, win the war, but we also know, as Mr. Baldwin has so often pointed out to us, that the lack of adequate transportation can contribute very materially to losing it. Every officer and supervisor is thoroughly imbued with the fact that we are all soldiers, and, through personal contacts, through frequent group meetings, and through the extensive use of circulars, bulletins and posters, everyone is kept tuned to the war effort.

More than 1700 of our former

fellow-employees are now with the armed forces. All of us have sons, relatives or close friends with the colors, so that the war does not seem remote and merely something one hears about on the radio or reads about in the newspapers. It's real and grim, and very personal. I mention this because we feel that salvage, reclamation and conservation efforts cannot be wholly successful unless they have the sincere and wholehearted co-operation of all employees, and we believe that you cannot secure this co-operation unless all employees realize the value of these efforts.

We on the Missouri Pacific Lines are proud of what we have



Line Abandonments Have Yielded Large Quantities of Bridge Steel for Reuse or Scrap

been able to accomplish. So far this year, our lines have plowed 48,000 tons of scrap back into industrial steel furnaces. Although the practice of moving scrap off the railroad and back into the channels of production has always been followed closely as a matter of good business and good housekeeping, scrap clean-ups were intensified immediately following our entry into the war.

We stopped considering scrap from a dollars-and-cents standpoint. If it costs \$50 to get out \$40 worth of scrap, we get it out. As a result, we have moved a vast amount of what might be called marginal scrap, and it is still moving. The same principles were ap-

plied to our reclamation practices, and we are now reclaiming materials that we formerly purchased, regardless of the economics involved, for the more we reclaim, the less demand we must make on the supply of vital materials.

The same patriotic principle and the same desire to be of service have been and are now actuating our efforts to furnish to the government as much of the vitally needed rail as possible, without, of course, in any way impairing the effectiveness of our operations. Intensification of these efforts began with the launching of the defense program and have been pursued even more energetically since last December. Much of the rail

Modified Standards on the M. P. Have Released Thousands of Feet of Inner Guard Rails From the Shorter and Lower Bridges on the Road



that we have turned over to the government resulted from the extensive new rail laying program that we have carried out over a long period of years, and which it has been possible for us to continue because of orders placed prior to our entrance into the war. Some of it has come from abandoned branch lines, and some of it from tracks serving abandoned industries and unused sidings. Our search for rail for the government, however, has extended beyond more or less orthodox sources.

Remove Many Guard Rails

Until recently, it had been our practice to install inside guard rails on all of our deck-type bridges 100 ft. or more in length and 10 ft. or more in height. This meant that we had thousands of feet of rail on our bridges for the purpose of reducing the damage that might result from derailments. To release much of this rail for tracks required in connection with the war effort, it was decided to modify our standards to provide for the installation of inside guard rails on only those deck-type bridges which have both a height of 20 ft. or more and a length of 200 ft. or more. Accordingly, a program was set up to release guard rails from all deck-type bridges which did not come within these limits.

Although we did not remove guard rails from through-type bridges under this program, we did adopt certain rules which permitted us to release part of the guard rails on some of the longer and higher deck-type bridges. On those where the track alinement is curved in excess of two degrees,

we eliminated the guard rail along the high side of single track; and all guard rails, except the one next to the low rail of the outside track, in double track. On double-track bridges with tangent alinement, we eliminated the guard rails on the outer sides of both tracks. Another rule which permitted the release of additional guard rails, called for their elimination at points where train movements are at speeds not exceeding 20 m.p.h.

Under this program, we have released approximately 320,000 lin. ft. of rail of various weights, some of it having only scrap value, but most of it being adequate for use in tracks serving war industries. The program is now complete, all rail having been forwarded to points of more effective service and making up part of the 400 track miles of rail released by the Missouri Pacific Lines in 1941 and 1942 to war plants, basic industries and military railways.

Save Other Bridge Materials

For many years our company had followed the practice of providing sheet-metal fire protection over the caps and stringers of open-deck timber trestles. This practice has now been discontinued to save the metal required by such a standard. Whether we will return at a later date to the former practice regarding the use of inside guard rails and fire protection metal is undecided. However, for the duration of the national emergency, it is proposed to avoid the use of these critical materials, since we do not feel that the added protection afforded by them justifies their use under present conditions.



Metal Tie Guards for Caps and Stringers Have Been Abandoned for the Duration

Other metal which it has been possible to salvage from existing structures consists of sidewalk brackets, pole brackets, light standards and other metal fixtures attached to steel spans and piers, and which are no longer essential. Such salvaged metal as this forms a part of the 48,000 tons of scrap which the Missouri Pacific Lines have collected.

In addition to salvaging rail and other miscellaneous metal, more careful consideration is now being given to reclaiming second-hand steel spans and beams in store yards, or which we may be able to recover from bridges on abandoned lines. Such spans or beams in their present form provide inadequate carrying capacity for modern railroad loading on main lines, but many of them can be altered so that they will provide the required carrying capacity. This can usually be accomplished by reducing their length, involving the rearrangement of their bracing and end bearings. Truss spans

of light design can often be reused by eliminating one or more panels to reduce the effective span length. This may call for some strengthening of the individual members remaining in the shortened spans, particularly the floor system, but the material eliminated from the panels removed can frequently be used to strengthen the members retained in the span.

A large per cent of the bridges on our railroads are of timber construction, many of them of untreated timber. Until a few years ago we were able to secure unlimited quantities of bridge timbers suitable for use untreated, and we are now passing through a replacement cycle. In recent years, therefore, we have had a rather heavy program of trestle maintenance and replacement, for which we have needed large quantities of stress-grade creosoted timber. In view of the War Production Board's Conservation Order M-208, covering softwood lumber, we will, undoubtedly, find it necessary to resort to greater use of second-hand untreated timber. To get the greatest possible use from the limited quantities of such timber available, we are arranging to apply creosote treatment to sound sections of second-hand timbers removed from bridges because of decay at the bearings. This material, as it becomes available, will be used in the maintenance of other untreated timber structures.

Salvage Building Materials

During the last ten years some of our station buildings, due to changed conditions locally or in the operation of the railroad, have become obsolete and have been

abandoned. For various reasons, some of these buildings have been allowed to remain in place, and we now find that they contain much valuable material which can be used in the maintenance of other existing stations and for the construction of needed station facilities at locations adjoining war industries. By razing such buildings, much lumber, mill work, corrugated galvanized roofing, asbestos shingles, brick, heating plant facilities, plumbing fixtures and their accessories have been made available for other work.

The brick and lumber recovered from one old building provided materials to construct a 55-ft. by 77-ft. extension to a warehouse at a nearby location, and a 30-ft. by 60-ft. shop building at another point. The materials recovered from another wood-frame building supplied practically enough second-hand lumber and millwork to construct a 38-ft. by 114-ft. building at a new location in the same town, and the excess of certain of the materials released was used to rehabilitate an existing freight warehouse.

A new station at Simms, La., serving Camp Livingston, was constructed of materials salvaged from a dismantled frame station at a point where it was no longer required, and a 48-ft. by 112-ft. warehouse was constructed in Illinois of materials salvaged from frame stations razed elsewhere. Asbestos shingles recovered from certain dismantled structures were also used to rehabilitate the roofs of two important main line stations.

In addition to utilizing the materials from razed buildings, a canvass of our system disclosed that many heating plants and

plumbing fixtures could be released at points where changed conditions no longer made them necessary. As a result, these plants and fixtures are now being salvaged for the maintenance and repair of facilities at other locations.

In a further effort to reclaim and salvage materials, we have undertaken a program of removing underground pipe lines which were abandoned in place, some of them having been abandoned for more than 15 years. These pipe lines are mostly of cast iron, but include some black and galvanized steel pipe. At the time they were abandoned, their removal could not be justified economically. Something like 200 tons of pipe, in sizes ranging from 2-in. to 12-in. in diameter, have thus far been recovered. Some of this was suitable only for scrap, but much of it has been reclaimed and is being reused elsewhere.

As shipments of this class of material are received at our reclamation plant in Sedalia, Mo., all pipe is inspected carefully and usable sections of pipe and fittings are cleaned and stored for re-use. We find that some valves can be reclaimed by re-grinding and supplying certain repair parts.

Some of your older employees, even those on the retired list, may supply valuable assistance in locating these hidden "treasures," where facilities have been abandoned for a period of several years. In effecting salvage and reclamation of major materials, the smaller items should not be overlooked. Much of the hardware removed from old bridges can be reconditioned for re-use. Worn cables removed from pile drivers and other equipment can be used for clump-

ing pile clusters at wharf and dock facilities, or for revetment work.

As to equipment, you are cautioned not to overlook the proper lubrication and adjustment of all machines, so that they will be kept serviceable for use at all times. It is no longer possible to secure the prompt delivery of repair parts.

Probably most of you have already thought of some or all of the possibilities for reclamation and salvage that I have mentioned. If not, it has certainly been worth the time required to recite them. Even if so, it may still have been worthwhile as a challenge to you to find other ways to reclaim and salvage those second-hand materials which you will surely need for the maintenance of your facilities.

As railroad men, you have probably read the recent comments of Chairman Aitchison of the Interstate Commerce Commission, to the effect that in the nationwide campaign to collect scrap, the railroads have taken the lead, and are doing a most remarkable job. This is true, but we must not rest upon our laurels and rely upon the good offices of War Materials, Inc., and other government agencies. It is our job to help, and we must keep ever alert to the possibilities of saving, reconditioning and re-using every available piece of serviceable material and equipment required in our work.

DISCUSSION

President Dove: I do not know of a railroad that has been more aggressive than the Missouri Pacific in collecting scrap and reclaiming materials. Mr. Hart has told us of the intensified campaign

which has been conducted. The railroads are whole-heartedly behind this scrap campaign. With the suggestions Mr. Hart has given us, we can go back to our own roads and do our part in this campaign. We are greatly indebted to you, Mr. Hart, for your remarks.

Have any of you men questions to ask Mr. Hart as to the manner in which specific items were reclaimed and salvaged on his railroad?

Mr. Caldwell (M. P.): Perhaps by design, Mr. Hart overlooked the canvass of the offices conducted throughout the Missouri Pacific Lines, looking for paperweights and door stops. To show the extent to which we went, I had a Republican elephant and a Democratic donkey as paperweights on my desk for a number of years. I have listened to them argue and they have changed my vote once or twice. Now, that they have gone to war, I won't know how to cast my ballot in 1944.

Mr. Hart: Mr. Caldwell is not joking about the collecting of paperweights. We actually did that very thing. We went through everyone's office in our main office building, and you would be surprised to know how many hundred pounds of little blocks of iron of one kind and another—souvenirs—we collected. I had a little metal model of a coaling station, others had sections of rail, etc. When it was all accumulated, it made a sizeable pile down in the lobby.

Mr. Caldwell: The general office contributed 375 lb. of brass and bronze from paperweights and door stops alone.

H. M. Church (C. & O.): I might

add that we are also using, to a limited extent, cables like those reclaimed on the Missouri Pacific, by heating them or running them through acid. These are being used in minor concrete structures, or other places, just to get by, where it would be very difficult for us to get new material.

W. A. Huckstep (M. P.): We made a cleanout in our office building. We own two buildings, one of which is leased to tenants. In cleaning up within our own office building, we uncovered several tons of scrap. I then went down into the sub-basement of the other building, 40 ft. below the street level, and found a linoleum roller of a type that I had been trying to secure for some time—a critical item which we could not get on the market.

Looking for Scrap

Elmer T. Howson (Ry. Eng. & Mtce.): The railways, as someone has said, have made a very remarkable record in this scrap campaign, both because they were used to campaigns of this kind, and because of their responsiveness to national demands. The versatility and ingenuity of railway men has never been illustrated more effectively than here.

In this room a month ago, Mr. Bertram, director of the salvage campaign for the War Production Board, cited instance after instance in which the railways had met this challenge quickly and thoroughly, and in a very effective manner. The possibilities are not realized by any of us until we really start looking for scrap.

There are so many things which we lay aside because we think we

may want to use them some day; these things accumulate and get back into a corner out of sight, as in the case of the roller which Mr. Huckstep found in the sub-basement of his office building. When there is an incentive to look for these things, they come to light and fill an immediate need, and, as a rule, the property is better off because it has been thoroughly cleared of all this refuse material.

To many men in this room, the things referred to by Mr. Hart are very suggestive of ways in which they can look for scrap. The influence of his paper is going to spread over many miles of railways.

Mr. Huckstep: W. J. Lacy recently recovered a lot of scrap on his division while we were looking for rails and for other articles that that might be lying around, as well as for things concealed under the ground. We also looked up, and in doing so we noticed a large amount of steel shafting in a large machine erecting shop of structural steel construction, shafting, running the full length of the shop, which had been installed when the shop was built many years ago. The idea occurred to us that this shafting was not essential, so we took it down at a good profit. I am sure there are similar possibilities on every road. We want to look up as well as down.

S. T. Corey (C. R. I. & P.): I would like to make a constructive suggestion, particularly about steel spans. How would it do for each railroad to report to some headquarters—to Mr. Hart, for instance—what spans it has on hand, for which it has no immediate or

near-future use? One railroad might have spans another road could use, and we might be able to help each other in that way.

President Dove: Do you know whether that suggestion has been made to the Association of American Railroads?

Mr. Hart: Yes, I frequently get copies of lists from the Association of American Railroads, noting the spans which the various roads have in stock and available for sale.

Mr. Church: I think the federal production boards have called for such lists, have they not? Such lists should be available upon written request. I think a number of the railroads are not reporting all of their surplus materials.

Mr. Corey: We had a request the other day from the State of Nebraska for a list of the spans we have on hand. I do not understand why they want this information.

Mr. Hart: They want to convert the spans for highway bridges.

Member: We have recently abandoned a line about 20 miles long, in which were two long viaducts. Stringers of heavy wide-flange beams were installed in 1931 to strengthen the viaduct for the service called for at that time. We felt these spans were lighter than we could use in the main line and were not really adaptable to main line use in other respects, so we offered them for sale. We had an inquiry from the State of Pennsylvania; it was eager to purchase these spans.

I might add further, that when we first considered abandoning this line, our mechanical department, which now finds it very difficult to

secure necessary critical materials for car repairs, immediately hit upon the idea that it could use much of the materials from these structures. It wanted practically everything in these viaducts—plates, angles, flats, bars, round bracing rods, etc.—to cut up and use in car repairs. In such a way, we developed quite a demand for this second-hand material. We also found that we could use a number of the girder spans complete in other work. As a result, not a pound of the material being taken out—and it amounts to some 600 or 700 tons—is going to waste. Uncle Sam is getting a little of it because it is of such a nature that it cannot be re-used, but the major part of it is being salvaged for other purposes.

Mr. Huckstep: I want to tell you how one division went to the extreme. This division had quite a building repair program set up for the month, but could not get flat tin discs for built-up roofs. To overcome this shortage, it gathered together all the tin buckets it could find and cut the discs out of the buckets, thus keeping the work going. The discs are now being cut from tomato and similar cans.

President Dove: I might also mention that one of the distinguished guests at our annual luncheon told me of a section foreman and gang of nine men who had collected more than 9,000 lb. of scrap, all off the right of way. It is, therefore, evident that we should not only look on the right-of-way, but also off the right-of-way.

Mr. Hart, please accept the gratitude of all present and of the association for your very fine paper.

The Problems Facing the Railroads

By Ralph Budd

President, Burlington System

(Introduced by President R. E. Dove)



Ralph Budd

neapolis, Minn., in 1927. He has not only been a friend for many years, but also a member of our association, of which we are very proud. He has been a friend to the whole railroad industry.

When the President of the United States was looking for a man to head the Advisory commission to the Council on National Defense, he recognized the fact that the railroads were a vital part of our national power and saw the need for a man who understood clearly the important part that the railroads would assume, and who could advise him on the problems to be overcome to insure the free flow of traffic. He chose a man from the Middle West for this important responsibility, Ralph Budd.

Mr. Budd advised the President concerning the strength of the railroads as well as their weaknesses, and he has done much for the railroads in seeing that they are given proper consideration in our na-

President Dove: Our speaker today needs no introduction to the members of the American Railway Bridge and Building Association. He addressed us at our meeting at Min-

tional plan for defense. We are very fortunate in having him as our speaker today. He will address us on the problems the railroads are facing.

It makes me very proud and happy to introduce him to you—Ralph Budd, President of the Burlington system.

Address by Ralph Budd

When reference was made to the fact that I spoke to you 15 years ago, it brought the comment from someone at the table that it has been a long time between invitations.

Meeting with a group like yours is always pleasant, because many years of my life were spent in the maintenance of way department and in close association with bridge and building men. I remember that as an assistant engineer I received a great deal of good advice and counsel from a very wise bridge and building superintendent. For example, the notes on my first fall bridge inspection were not very complimentary about some of the structures. This gentleman, in going over the program with me, said, "Now, you know, the worst term we use about a bridge in our permanent notebook is that it is fair, for 'fair' means that something ought to be done." It was a friendly tip. That must have

been about the time when the bridge and building foreman was riding a locomotive at pretty high speed and the engineer said to him: "It takes a lot of nerve to run a locomotive as fast as this" and the B. & B. man replied: "It doesn't take half as much nerve for you to run so fast as it does for me to ride with you; I know what we are running over."

Great Responsibility

Today, all of us with the railroads, as all other good citizens, are concerned chiefly with one thing, and that is what we can do to help win the war. I notice in looking through your program that, most appropriately, the subjects cover various effects of the war effort. In talking with railroad men of all types, but more particularly with operating men, since the war broke out, the thought recurs that we are at once a very favored group and, at the same time, one charged with great responsibility. We are favored because we are engaged in a business which is definitely a part of the war activities, and one that should never be thought of as apart from them. But, as often happens, that privilege carries with it a special duty. Ours is to see that there is no delay in the transportation of men and materials of war.

I feel very sorry for employees and officers in many fine industries which were very important in peacetime, but which because what they produced is not considered essential, or because the services they rendered are not needed in war, have been obliged to convert their plants, or to discontinue their operations and find other employment.

In the case of transportation we now carry different manufactured products than we have in the past, although the raw or bulk commodities still are about the same. Iron ore, coal, copper and lumber move as before, whether they finally come out of factories as refrigerators and automobiles or as guns and tanks; likewise food and clothing move much the same in war as in peace. The change in transportation service is a matter of volume and different traffic requirements; many special movements are now necessary. But our service can meet the war demands without any retooling, without any material change in the plant, by merely hauling a larger volume of raw materials and different kinds of manufactured articles for a different group of shippers, now chiefly employed by the Government, or for the Government itself as shipper.

Part of Home Front

Our resolve, of course, should be to do our utmost each day toward the war effort. And such resolve is appropriate also for members of the many government staffs dealing with the railroads; the same test is applicable, because putting a man on a government payroll and moving him to Washington makes him no more a patriot than retaining him on the production line at home. Transportation is part of the home front.

Some months ago General Armstrong, who was then in charge of ordnance production in Chicago, made an award to the Walworth Company at Kewanee, Ill., on the occasion of its completing its one millionth shell. The high light of the meeting occurred when Gen.

Armstrong presented a man and his twin sons to the audience. One of these boys was in army uniform; the other twin and their father were in the overalls of the Walworth Company. Gen. Armstrong said to those assembled, "There is no difference in the contribution these twin brothers are making; the one is as necessary as the other."

Coming more specifically to what those of us here can do, two or three things may be mentioned. One is care in the use of materials which have now become scarce; another is the use of substitute materials where possible. Full service life must be obtained from material in actual use; replacements must be made only when necessary; nothing should be wasted. No more material should be asked for than is needed, and that necessary amount should be ordered well in advance. Non-critical materials should take the place of scarcer materials wherever it is practicable.

Must Train New Men

To no less degree, careful attention must be given to personnel. A manpower shortage may well become more controlling even than a material shortage.

Many new and inexperienced workers are being added to the railroad payrolls. The kind of railroad men they will be depends to a large extent upon the training they receive from their fellow employees, their foremen, and supervisory officers. These new employees will form a good or bad opinion of the railroads generally, and of their own companies, and will be valuable or otherwise, depending largely upon how they are

treated. And most of their training will have to be on the job. Here is another example of the responsibility and duty that go with the privilege of being essential members of the family of railway employees. Every railway officer has an opportunity in this regard.

The matter of safety is another thing to consider in training new men. Materials and tools must be used safely as well as providently. I have before me some data on safety which are rather impressive, and in some ways not particularly gratifying. Accidents have been increasing. The explanation, no doubt, is in the larger volume of traffic which is being handled, and the large number of new employees. In 1941, there was an increase in casualties to employees on duty of 25 per cent over 1940—a large increase. Thus far in 1942, the accident records indicate a still further increase. These increases, however, are in comparison with years when our safety record was extremely good.

It has been mentioned that I talked to you 15 years ago. Mr. Howson recalled to my mind that at that time I spoke with pride about the safety record the railroads were making. It is interesting to compare 1941, which was not as good as 1940, with 1927, which we then thought was excellent. The decrease in the casualty rate for 1941 compared with 1927, was 56.9 per cent; for 1940 compared with 1927, the decrease in the casualty rate was 65.6 per cent. The accident records of the railroads constitute a challenge which is always present, and the idea of carefully training and helping new employees is an important part of the answer to that challenge.

Post-War Planning

Now, even though we are in the midst of war, and the first job is to win it, a word should be said about conditions following the war and what, if anything, can be done at this time to meet the problems which will confront us then. The term "post-war planning" seems rather unfortunate, because it may imply a neglect of the task of winning the war. Consideration of the post-war status of industry, however, is vital for several reasons, but chiefly because of the dislocations which have arisen from shifting to a war-time basis, and the greater ones which will arise from the inevitable shift back again to peacetime pursuits. This change, unless some procedure is worked out in advance, may well result in near chaos economically, and that would bring serious social unrest. There is danger that a situation might eventuate which, without plans having been made for employment by private industry, would require the government to bridge the gap with a great deal of public work at a time when the public debt already is staggering.

I am one of those who believe that the use of funds by government agencies to increase general employment can never take the place of the expenditures which private industry can make. For this reason, I think it is well for those who believe similarly to see what may be done in the way of preparation. I believe such advance preparation is, indeed, essential to the achievement of total victory.

There are schools of thought along the two lines—one, that the job will be too great for business-

men to cope with and, therefore, that the government must take over; and the other, that reliance must be in private enterprise, with a minimum of government spending.

Both ideas are expressed and developed quite frequently, but there is one aspect concerning which I have heard very little, and it is that the prerequisite for successful private business and maximum employment after the war is a constructive and friendly governmental attitude and policy toward business. Particularly is this necessary for those enterprises which are providers of services rather than producers of goods. The railroads, for example, which afford a nationwide public service, must, of course, be subject to regulation, but that regulation should be of a practical and positive character, administered in a manner to promote successful operations. Also, there has been too little stress on the importance of having it understood that the restrictions and inhibitions which all industries are accepting willingly now, because of the war, are understood to be only temporary controls, and will be removed as promptly as possible after our victory. That, together with governmental policies which will encourage venture capital in the types of activities which have created such phenomenal industries as steel, automotive, chemical and the various electrical manufacturing, is what are most needed. The initiative which has provided so much employment and raised the level of living so greatly will go a long way toward becoming the spark plug for the future if given a favorable atmosphere by government.

Technological Developments

The railroads will not lag in ingenuity, or inventiveness either, if they are afforded such fair treatment. There has been continual progress in your particular department, both in bridges and buildings, from the use of wood and stone to cast iron, wrought iron, rolled steel, concrete, and finally, metal alloys. In railroad equipment, we find the same general trend. For the time being, we must give up many technological advances, because certain critical materials are not obtainable, but when they can be had again, we will start where we left off, or perhaps a little farther along, by taking advantage of the developments that are being made in implements of war. These have been very great, especially in metallurgy, internal combustion engines and aviation.

You are familiar with the rapidity with which the evolution in bridge and building construction has taken place. Perhaps most of you know that the first skyscraper-type building ever erected was here in Chicago. The American Institute of Architects has stated that the first example of skeleton construction, in which all floor and wall loads are carried by columns to the foundation, was the Home Insurance Company Building, completed in 1885, on the northwest corner of Adams and La Salle streets. This building was designed by William L. B. Jenning, architect, in 1883. As there had been considerable controversy regarding the first use of skeleton construction, a committee of architects and engineers inspected the construction during the wrecking

of the building, starting October 1, 1931, and made a careful report of its findings.

The original building was 10 stories in height, and two stories were added during 1890 and 1891. Starting with the third floor, construction was of cast iron. The girders were two 12-in. wrought iron beams; the floor joists were 8-in. wrought iron beams. Between the sixth floor and the roof, some Bessemer steel 9-in. wall beams were used.

About that same time, steel took the place of wrought iron and cast iron in bridge work. The earliest steel truss spans, to my knowledge, were on the Alton Railroad's bridge across the Missouri river at Glasgow, Mo., built in 1879. Prior to that time, wood, stone, wrought iron, and cast iron were used. The engineer who designed and built this bridge was W. Sooy Smith, who later built the foundations for the Burlington's bridge across the Missouri river at Plattsmouth, Nebr.

We have some remarkable examples of old bridges on the Burlington. One of these now carries street traffic at 52nd avenue in Morton Park. It consists of four 250-ft. truss spans, which were built in 1867 for the Mississippi River bridge at Burlington, Iowa. They were re-erected at Morton Park in 1894. The spans have cast iron top cords and end posts, the balance being of wrought iron. The original structure is still in a good state of preservation.

Must Have Necessities

I am confident that the resumption of the rapid evolution which was interrupted by the war is as-

sured if the opportunity is afforded. The railroads are now carrying more ton miles of freight and more passenger miles than ever before, and it is estimated that the load will increase in 1943. The immediate railroad problem, therefore, is to get the materials and the manpower vitally necessary to handle this growing traffic, and this necessity must be recognized by those in Washington who have authority to say to whom the supply of material and manpower will be allotted.

We are fortunate at this juncture that Joseph B. Eastman, Director of the Office of Defense Transportation, is in general charge of transportation, because he knows very well how much the railroads are capable of doing,

when they have reached their limits, and, therefore, when it is necessary to give them more materials. In an address only last week, he warned the public that that time has been reached. We must have the necessary materials, we must have the necessary men, and if these are permitted, I have the fullest confidence in you men who are present here, and the many others on the railroads like you, to continue present eminently satisfactory results.

President Dove: Mr. Budd, we appreciate your taking the time from your many duties to come to us today with this address. I feel confident that I express the feeling of everyone in this room when I say thank you.

Wearing Surfaces for Building Floors, Platforms and Roadways

Report of Committee

Committee—T. H. STRATE (chairman), div. engr., C. M. St. P. & P., Chicago; W. F. HUTCHESON (vice-chairman), asst. supv. b. & b., C. & O., Newport News, Va.; L. E. PEYSER (vice-chairman), asst. arch., S. P., San Francisco, Cal.; R. C. BAKER, supv. b. & b., C. & E. I., Danville, Ill.; Maxfield Bear, est., C. & N. W., Chicago; G. W. BENSEN, supv., b. & b., C. of Ga., Macon Ga.; ARMSTRONG CHINN, ch. engr., Alton, Chicago; H. M. CHURCH, gen. supv. b. & b., C. & O., Richmond, Va.; G. V. COFFEY, asst. supv., b. & b., M. C., Jackson, Mich.; C. DJUVIK, engr. of b. & b., T. C., Nashville, Tenn.; R. G. HILTON, asst. engr., M. P. Houston, Tex.; K. E. HORNING, arch. draftsman., C. M. St. P. & P., Chicago; N. D. HOWARD, managing editor, Railway Engineering and Maintenance, Chicago; J. A. JORLETT, mast. carp., Penna., Pittsburgh, Pa.; T. C. SAUNDERS, engr. asst., T. & N. O., North Bay, Ont.; and C. U. SMITH, general manager & ch. engr., Board Harbor Commission, Milwaukee, Wis.



T. H. Strate
Chairman

railroad. Likewise, it is in the offices, freight houses, shop buildings and engine houses that the wearing surfaces of floors are ever before the employee. All in all, it can be said that the wearing surface is the common ground on which all of the human element involved in the operation and support of the railroad has its meeting.

The proper maintenance and construction of these wearing surfaces in the various facilities of a railroad constitute a major item in the bridge

The importance of wearing surfaces in the operation and maintenance of railroads is most apparent when thought is given to the fact that it is on these surfaces in station buildings, platforms and roadways that the public comes in contact with the

and bulding department's responsibilities. Each installation of a wearing surface must satisfy certain requisites established by the particular type of traffic, as well as the age-old limitation of cost. Safety is a factor which should always be given careful consideration in any wearing surface, whether to prevent injuries to patrons or to employees.

It is therefore logical to state that each installation of a wearing surface shall be given special attention and a careful study be made to determine the best type of material to meet the particular requirements.

Wood is probably the oldest generally-used material in surfacing important railway platforms, consisting of plank and end grain block. Concrete, mastic-coated concrete, asphalt and brick are also used. The floors most widely used are of wood-composition, tile or terrazo.

Freight house floors are predominately of wood-plank on a frame substructure. Some floors are of concrete on earth fill or concrete on a reinforced substructure. Shop and engine house floors are generally of either wood block or concrete.

Shop driveways, team track driveways and pedestrian walks are chiefly of concrete, with some brick.

Among all of these major types will be found the common fill platforms and walks, consisting of either cinder or screening top.

Requirements for Wearing Surfaces

(1) Important passenger stations.

In such structures the floor surface must be highly resistant to the abrasive action of heavy pedestrian traffic. It must have a surface texture which will not be slippery when either wet or dry; yet the texture of the surface must permit easy cleaning. The material must be water repellent. The wearing surface shall be on a base which provides some resiliency for walking ease of the patrons. The surface shall be of a pleasing or neutral color that reflects, rather than absorbs, light. The presence of sound-absorbing qualities in the surfacing would be advantageous.

(2) Second class passenger and freight stations.

Because of the nature and volume of the traffic imposed upon the wearing surface, abrasive resistance is of minor importance in structures of this type; resilience and sound deadening do not warrant consideration. However, since janitor service is rarely provided at this type of station, and the agent-operator is usually also the janitor, ease of cleaning and a non-slip surface should be stressed. Light-reflecting properties should also be considered for this type of station is seldom adequately lighted.

(3) Offices.

Sound absorbing qualities are of prime importance in office floors, and resiliency is of only slightly less importance. The floor must be of such hardness as to enable it to withstand heavy concentrated loading without being indented. It should also have

a dull finish capable of reflecting light without glare, and must, of course, be easy to clean.

(4) Important freight stations, including warehouses and piers.

Smoothness is probably of most importance in floors of this classification, because of its effect on both handling costs and damaged freight claims. Of equal importance is the hardness of the wearing surface and its resistance to concentrated wheel loads. Rigidity of the surface, instead of resiliency, must be provided here for ease in operating wheel trucks.

Another very important characteristic for this type floor is imperviousness to moisture. Its absorbent qualities must be nil. It must be odorless and should have no properties that will stain shipments; it should not be able to impart a taste to merchandise, especially food stuffs. It should be as nearly dust-proof as possible and lend itself to quick and economical repair. Its substructure should be permanent and of sufficient strength to withstand very heavy loadings, as loads in excess of 300-lb. per sq. ft. are not unusual on such floors.

(5) Shops and engine houses.

In buildings of this type the floor must be impervious to oils and greases as well as to hot and cold water. It must be able to withstand shock from the impact of falling objects. It should offer some resiliency to the workmen, especially in machine shops. It must be such texture that when coated with oils, greases and water it does not become slick and it should be easily swept or cleaned. It must be of such strength that it can withstand heavy concentrated loads such as are imposed by jacks.

(6) Pedestrian walks, loading and trucking platforms.

As most facilities under this classification are open and exposed, the first consideration in their construction should be their resistance to the elements. Another important characteristic should be their ability to free themselves of surface water quickly. They, like all other wearing surfaces, must be hard and resistant to abrasive wear and to wheel wear under heavy loadings. Those located in colder climates must be resistant to ice-melting chemicals and thawing agents.

(7) Roadways for terminals, team tracks and station roadways.

Wearing surfaces here are of less importance than their supporting structure, as most modern traffic over these surfaces is vehicular on rubber tires; however, their surface drainage is of vital importance and must be adequate to enable them to drain free of water quickly under nearly cloudburst conditions. In general, they should be of the same construction as adjoining streets.

Wood Plank and Block Floors

Wood plank flooring is still the wearing surface material of lowest original cost. However, the cost of maintenance may be high although this factor will not be discussed in this report, because of the numerous use conditions which affect such figures.

Where planking is laid on a wood joist supporting structure, it is recommended that the joists be of such dimension as will provide a wide surface for nailing, the minimum width being three inches. This will insure full gripping power of the nails or spikes, by eliminating the tendency to nail through a corner of the joist. Such joists will also provide sufficient width for end butting of planking to keep the nails

a sufficient distance back from the end of the plank to provide good nailing.

When plank flooring is to be laid over a concrete sub floor, the plank shall be placed on bevelled sleepers which shall be a minimum of 3 in. by 3 in. The sleepers are to be set in the concrete, or bituminous material, at the time the sub-floor is laid.

Wood-finish floors, which are usually edge grain fir or maple, have proved very suitable for use in stations and offices and are usually laid over a one-inch wood sub flooring.



Floors at Important Freight Stations Must Be Smooth and Wear Well Under Heavy Trucking

This type of floor is also laid on sleepers set either in concrete or bituminous material and in all cases the fastening is by blind nailing.

Laminated types of floors of either treated or untreated materials have been used but they are expensive and in most instances their cost is not justified.

The types of fastenings for wood floors consist of common nails and spikes, cut nails, boat spikes, lag

screws, drive screws and bolts. Boat spikes or double grip spikes are recommended for the fastening of plank floors and cut nails for the blind nailing of maple finish floors.

Where platforms or floors are required in tracks where frequent surfacing is necessary, a type of wood construction is desirable that can be removed in sections so that the timbers will not be damaged by pulling and re-driving the spikes.

End grain wood block floors are very desirable for conditions where heavy traffic exists, if protected from the elements, as in a freight house. Such floors offer great resistance to heavy wheel loads. In this type of floor the wood blocks are laid tight and embedded in hot asphaltum pitch on a sand cushion over a concrete sub floor. Where this type of floor is exposed to the elements, water and moisture swell the blocks, and, combined with frost action, heave them out of place. It is recommended, therefore, that exterior use of this flooring shall not be made.

Concrete Floors

The use of concrete for wearing surfaces has proved highly satisfactory for all uses which require wear resistance to heavy loads as well as the elements. It is readily cleaned and therefore is found adaptable to many uses on a railroad.

Since the quality of the concrete is controlled by many factors of materials, mixing, placing and curing, this report will not attempt to discuss these factors. Most of the railroads have in their engineering departments specialists in concrete design who work with experts of the Portland Cement Association in combating specific problems.

There has been considerable discussion relative to the merits of a

monolithic floor slab versus two course construction which employs a subfloor with a one-inch finish topping. The monolithic type is the simplest and least expensive for the entire floor slab is placed at one time. For this type of floor it is necessary to use an inexpensive mix which may be difficult to finish as smoothly as may be desired. The two-course type of construction, in which a base is first laid and a topping approximately one inch thick is laid at a subsequent time, permits the use of a more expensive mix for the topping. With this method a mix can be used which is adapted especially to the type of service and a good smooth surface is easily secured. Disadvantages are the added expense of the additional operations and the danger that the topping may not become well bonded to the base slab, unless great care is taken. To overcome this last difficulty, a combination of the two types of construction is sometimes used, in which the topping is placed before the base slab has set. This requires good timing and organization of the crew laying the floor.

Where concrete has been used in engine pit construction, many problems have arisen from the use of locomotive jacks on jacking pads. The concrete in the pits has withstood the loadings placed upon it, but the surface of such jacking pads has become destroyed by the jacking operations. This problem has been combatted by placing a steel grating armor on the jacking pads.

The use of concrete for floors, walks, steps, etc., in passenger depots has long been a problem for bridge and building forces, because of the accidents which occur from patrons slipping on these surfaces. The introduction of an abrasive in these surfaces is recommended to combat this hazard. On walks and

floors, the abrasive is worked into the surface with the finish troweling. For steps it is recommended that precast abrasive strips $\frac{3}{8}$ in. to $\frac{1}{2}$ in. wide be set into the front part of the tread. The manufacturers of these precast strips prefer to cut the grooves and place the strips after the stairs are cast and set.

Terrazzo, Magnesite, etc.

Terrazzo floors have a definite place in important passenger stations where their cost can be justified. These floors have excellent wearing qualities, are not slippery, are easily cleaned and offer unlimited possibilities in design and use of color to harmonize with the interior scheme.

The floor commonly known as magnesite, which is a magnesium oxychloride composition, has a wide use in the surfacing of existing wood floors. A $\frac{1}{2}$ -in. layer of this material is laid and troweled to a smooth hard finish, which is impervious to moisture and does not burn. The material can be carried up on the walls to form a cove base and is therefore worthy of consideration for use in locker rooms, etc., which necessitate a floor which can be cleaned easily and thoroughly. Magnesite floors have been found to become slippery when wet and are not recommended for toilet rooms.

There are many composition surfacing materials such as rubber, cork and asphalt tiles, linoleums, etc. These materials are not designed for long life in places of heavy traffic. However, they have an important field on the railroads in that they provide an attractive floor for second class passenger stations and offices. They give a resilient, sound-absorbing surface which is desirable for this type of service. They do not offer a great deal of resistance to

abrasion, are easily indented by concentrated loads and therefore consideration must be given to the use to which they will be subjected.

A very complete and thorough analysis of the wear resistance of all of these materials is made in report B.M.S. 80, Building Materials and Structures, published by the National Bureau of Standards, Washington, D.C.

Platforms and Curbing

At stations of minor importance which have light traffic, an economical surfacing for platforms and roadways may be constructed of bituminous material. This material may be either premixed or mixed in place and hand-tamped or rolled with heavy rollers to a hard compacted surface. The result is a surface which is resilient, does not get slippery when wet and holds up very well under wheel loads, particularly solid or pneumatic rubber tired wheels. These materials lend themselves to the repair of any bad spots which may develop, as the new material in a patch readily bonds into the existing platform surfacing.

Brick as a paving material has many years of service to prove that it has excellent qualities for use in walks, platforms and team tracks. However, the success of this type of paving depends upon the base on which it is laid. A concrete subfloor is by far the most satisfactory. As a binder, both asphaltum and cement grout are used, asphaltum being preferable for driveways and cement grout for walks and station platforms. Paving brick is very resistant to salt and chemicals used to melt ice and snow on platforms, which is one reason for the continued use of this material.

The curbing becomes a very im-

portant part of each paving project in which brick, screenings and bituminous products are used. The curbing serves to hold the material in place at the edges of the platform or walk, as well as to give a straight and finished line, from the standpoint of appearance. Timber and precast concrete curbings are the most widely used for railroad purposes and each railroad has its own design for the use of these materials to suit the conditions prevailing.

Your committee does not recommend any one material for each facility, since the conditions of traffic, the elements, the availability of materials, etc., will necessarily affect the choice.

DISCUSSION

President Dove: I note one of the things mentioned in the report is the matter of brick paving. I think one of the strong reasons for the continuance of the use of this type of paving is the salvage value of the brick whenever an area is to be resurfaced or the brick is to be taken up and replaced.

Another point which I think noteworthy is the matter of removable sections of planks around stations and between tracks. As the report points out, by having this type of crossing, it can be removed without damage when it becomes necessary to surface the track. The matter of material, especially lumber, is so acute, and will probably continue to be so in the coming year, that I think we should make note of this suggestion.

L. C. Winkelhaus (C. & N. W.): On our road, considerable asphalt tile flooring—not mentioned in the report—has been used in modern-

ization work on a number of our more important passenger stations. These tiles were 6 in. by 6 in. by 9 in., and 12 in. by 12 in. in size, depending on the size of the rooms. This type of flooring has generally been applied with very satisfactory results over existing wood floors, and is recommended for consideration because of its effective service and reasonable cost.

President Dove: This is a very interesting subject, as we all have floors and platforms which require attention from time to time. I was particularly interested in the reference to two-course concrete. What are the conditions that warrant this type of surfacing? It certainly calls for close timing in order to insure the proper bond between the two courses.

Metallic Wearing Surface

A. L. McCloy (P. M.): We have about 10,000 sq. ft. of concrete floor to be laid in a car shop. The specifications call for a 1 in. top dressing, but I have hesitated to start the work because I am afraid we will get a separation between the two courses. I wonder if anyone has had much experience with monolithic pour with metallic siftings in the surface, and what kind of a job you get? What I contemplate doing with this floor is to pour it monolithically, and then apply a metallic sifting in the top wearing surface. Several companies manufacture a sifting which they claim gives a good metallic wearing surface.

G. V. Coffey (M. C.): We found that a uniform distribution of the siftings can not be obtained be-

cause of the type of labor we have had to use, and that, due to truck wear, which causes the chipping of soft spots, resurfacing was necessary within a year or two.

I think you will all agree that admixtures are as yet not satisfactory in the placing of concrete, either in two-course or one-course work. After the cement experts have developed these a little more, they may be effective, but at the present time, I think you will find they merely increase the cost.

Mr. McCloy: I have understood that the cost of this type of surface is no greater than the cost for other types of flooring, when the extra labor for making two pours on such types is considered.

Mr. Coffey: Unless you have more experienced labor than we now have, you are certain to get a concentration of the sifting.

Mr. McCloy: Unless you have something on the wearing surface of concrete floors, you will also get some bad spots worn into the floor.

Mr. Coffey: That is right. The surface should be laid in two courses, so that the admixture can be mixed with the topping, thereby getting a uniform distribution and mix. I am afraid that if it is trowled in, you will not get an uniform distribution.

John Hayes (G. N.): Out in the post office garage in Seattle, Wash., the government Post Office department wanted a hardener put in the floor being laid, so we used magnesium crystals and water. The slab was poured monolithically; after it had set up for about 12 hours, we put on the magnesium fluosilicate and water. It was put on in three coats, using less water

in each coat. You put on as much as the slab will take the first coat, then put on another application, and go over it the third time until the concrete has quit drawing. The material then floats on the surface, and it is all washed off later. This gives a real hard surface. You can scrape the concrete with a screw-driver where you have not made this application and get a dust or powder. However, if you scrape the surface prepared with the crystals and water, you get no concrete dust at all.

The Minneapolis - Honeywell Company put hardener in all of its building floors, using a product consisting of sulphuric acid and a compound. We used this product on an experimental surface in St. Paul. It is applied after the concrete has been poured in one slab, and one coat only is used; it is floated on and is inclined to bubble. Although the application of this product is unpleasant because it has a tendency to choke the person applying it, the same test mentioned above can be made after the compound has been washed off. About 15 min. after putting it on, no dust or powder will come off the surface. One gallon of this will cover about 100 sq. ft., and the cost of the product is \$1.50 per gal.

The Post Office department in Seattle wanted a floor free from grease at all times. We found that grease will not stick to the concrete slab or spot the slab after the hardener has been applied, and we think the preparation used there will work out very well.

President Dove: How do you apply this preparation to the surface; what method do you use?

Mr. Hayes: You just pour it on. The sulphuric acid compound

comes in a five-gallon crock, as it will not stand up in a metal container. It is poured from the crocks onto the surface and spread around with a rubber squeegee. The men applying it should wear rubber boots as this preparation causes serious damage to leather shoes. This operation can be performed by a couple of men.

This preparation gives a more satisfactory surface than untreated floors in so far as the powdering of the concrete is concerned. Of course, we used a good mix; a 1-2-3 mix, 2500-lb. concrete, reinforced with bars, but it still powders unless treated. You cannot get away from the powdering altogether.

Mr. Coffey: Has your experience been sufficient to determine how slippery the floor becomes when wet?

Mr. Hayes: They wash the trucks in the Seattle post office garage, and I have heard no complaints. Although the surface was not finished perfectly smooth, neither is it rough. We have poured a number of floors and finished them off with a broom, but have found this to be unsatisfactory, because where the floor is rough, the particles sticking up are sand, and wear off readily. Following is a set of instructions for applying the hardener consisting of magnesium fluosilicate crystals and water:

Concrete Floor Hardener

First, sweep the concrete floor clean. Then mix $2\frac{1}{2}$ lb. of Magnesium Fluosilicate crystals to 1 gal. clear H_2O in a wood container. This solution will be called the hardener.

The first coat of hardener should be mixed on the basis of 1 part hardener to 2 parts clear water.

Brush this solution over the floor generously, letting the concrete absorb all it will take. Let this stand for 12 to 24 hours before applying second coat.

The second coat should be mixed with equal portions of hardener and clear H_2O , and brushed over surface in the same way as the first coat.

The third coat should be applied on the basis of 2 parts of hardener to 1 part of clear H_2O . After letting this stand 12 to 24 hours, rinse the surface with clear H_2O .

President Dove: Another method of preserving the wearing surface of plank flooring is to mop them with an asphalt emulsion and then sprinkle them with sand. This is particularly effective on indoor work.

Chairman Strate: Some three years ago, we built freight transfer platforms, about 2,000 ft. in all, at Galewood in our Chicago terminal. About one-third of these platforms were 60 ft. in width, and the balance 40 ft. The platforms were constructed on creosoted piling, with reinforced concrete slabs and with hex-steel surface. In spite of this construction, we still have trouble from the steel wheels which we use on our freight trucks and trailer trucks. The concrete, of course, is worn down to the surface of the hex-steel, and is quite dusty. I believe the solution to our troubles would be the use of rubber-tired wheels on the trucks.

President Dove: Of course, you must consider that the rubber castings would be difficult to get at this time.

Is there any further comment on this report? If not, we will dismiss the committee with the thanks of the association for its fine work.

Reducing Demands for Cars and Locomotives in Company Service

By W. D. Beck

District Manager, Car Service Division, A. A. R.

(Introduced by President R. E. Dove)



W. D. Beck

From the addresses and the discussions of the last two days, the importance of the railroads in the country's war effort has been made quite clear. A very important cog in railroad transportation is the matter of cars. With the number of cars available, limited as it is in these days of peak loading, and with the probability of

securing new equipment slight, it becomes a matter of great importance to keep our present supply of cars in constant use.

It is believed that the railroad employees are not fully aware of the importance of this fact and are among the principal offenders in keeping cars too long under load. In view of this, we have asked a man to address us this morning on how we can better our record in this respect. I am happy to present W. D. Beck, district manager of the Car Service division of the Association of American Railroads. He is thoroughly familiar with the subject of car supply.

Address by Mr. Beck

As I sat here this morning, listening to the discussion, I found it most interesting, because it carried me back to the days when, as a young cub of a superintendent, it was necessary to supervise some of the things concerning which you have been talking. In those days, many of the things mentioned this morning were "Greek" to me. Today, I have no better interpretation than I had at that time, and I depended largely on men of your type to keep me in favor with the general office. I want to mention one in particular. W. C. Halsey, who many, many years ago was superintendent of

bridges and buildings of the North Western at Eagle Grove, Iowa, was an interesting man. We referred to him, behind his back, as one of Napoleon's generals, because he was always able to accomplish those things which he set out to accomplish, and to do so with the least expense. In those days, as now, expense was a very large factor.

Then, I also thought about the public's general idea of railroading and how little they know about the troubles and the anxieties confronting you gentlemen day and night in order to provide the safe carrying of passenger traffic and

freight. I say day and night advisedly, because I know that you are on duty 24 hr. a day and that it is very largely in your hands whether these trains, streamliners or 150-car freight trains thundering across the country as they do today, arrive at their destination safely. It should make all of us happy to learn, not only from general observation but by referring to statistics, that 99.91 per cent of these trains reach their destination safely. Passengers, troops and freight have all been delivered, even in these days of heavy travel, to the eminent satisfaction of all those dependent on railroad travel.

When Mr. Howson asked me to speak to you about the possibility of saving railroad equipment, I accepted the invitation with alacrity because I felt that it was my duty to add anything I could to your information and possibly supply added impetus to the end that the people you supervise—and they are legion—would get the story about conservation of equipment. When I say equipment, I mean not only cars but locomotives.

Shippers' Boards

First I want to tell you what our patrons, our shippers and receivers of freight, are doing. There are in the United States 13 Shippers' Advisory Boards. The first Shippers' Advisory Board was formed at Minneapolis about 22 years ago. Mr. Gormley, whom you all know, conceived the idea (and it has proved to be a brilliant one) that if he could get the shippers and the railroad people, particularly the operating people, together, they could iron out among themselves many of the difficulties with respect to car shortages. As an

example, those of you who have lived through the fall months in the Granger district know that for years and years we had grain car shortages every harvest. This situation was brought about by many things, but very largely by the fact that the shippers pyramided their orders. If they lived within five miles of three railroads, they placed orders on each of the roads for one, two or three cars, or whatever they required, with the result that each railroad was providing cars and suffered because of the idle equipment.

Since the 13 Advisory Boards have been organized, there have been no car shortages of any consequence. There have been sporadic car shortages, of course, but, generally speaking, the car supply has been adequate.

Shippers Co-operate

About a year and one-half ago, these shippers decided that they had a very definite responsibility as to the equipment on the railroads; that if any shipper ordered and used two cars where one would suffice, he was not working for the common good, and if he kept cars 96 hr., or 48 hr., or even 24 hr., he was not doing his part. So they formed "vigilance" committees. We now have 65 of these committees, located in strategic towns in this district. These committees of shippers have made it their business to see that the shippers load and unload cars promptly, bill them promptly and clean the cars of dunnage, waste and rubbish after unloading, so that they may be made available to the next shipper without going to a cleaning track. The shippers have accomplished marvels and are still ac-

complishing them. The 48-hr. loads on track for industries in this area, where we have something like 20,000 industries, are down now to about 15 per cent of the total, and thousands of cars are being unloaded on the same day or within 24 hr. after arrival.

Cars with Company Material

This has no relation to your particular problem, but I paint such a picture as an illustration of what we should do. When I say we, I mean all of the railroads—you and all of the organizations which have to do with the use of equipment for the handling of company material—and I must add, with some disappointment, that the company material situation on the railroads generally is far from satisfactory.

The latest figure available—I think it was for September 1—shows 57,000 cars with company material in them. Some of this material is coal; some is coke, ties, angle bars or bridge timbers; some of it is steel for the various bridges you have mentioned; some of it is comprised of a miscellaneous assortment of all types of material for the operation and maintenance of the railroads; 57,000 cars, which approximates five per cent of the total number of cars owned.

Now, considering company materials other than coal and coke, for which maintenance men have little responsibility, the situation is almost tragic. The cars used for this material, which are usually fit for the handling of any type of freight, are held anywhere from 3 to 25 days. Very few of them are company cars or maintenance cars. Rather, they are all generally high-class cars, and it is this equipment I urge you to release rapidly.

I think I am somewhat familiar with the difficulties the maintenance of way people have in getting their material taken out and unloaded at the point where it is to be used. They have difficulty getting the way freight to take them, because in the remote areas the conductor is usually the man who says whether he will or will not take them. He may have a hard day's work ahead of him and may pass up a car of material, unless a complaint is made to someone else.

Let no one pass up a carload of material which you are prepared to unload. Insist that it go out the day you want it, and be certain the day you want it is not more than 24 hours following the receipt of the load at a particular station.

It is urged that, in so far as the placing of these cars on way freights or switch trains is concerned, you use your influence with the operating officers in attempting to show them, if they be recalcitrant, that a little overtime paid to the way freight or to the switch crew is money well spent as compared with waiting until you get 20 or 25 cars, or enough to order a work train and a locomotive with a train and engine crew to handle the material. By using a work train, first you delay the unloading of most of the cars a week or 10 days. Secondly, you have taken a locomotive out of other service and every locomotive is needed today to move the freight which is being offered to the railroads.

I may say, incidentally, that car loadings are running well over five per cent ahead of 1941, and I have no hesitation in predicting that

they will be 10 or 15 per cent more in 1943 than in 1942. So anything you men can do, or any advice you can give your co-workers on your particular railroads with respect to releasing company material promptly and not wasting locomotive power, will certainly be helpful in furthering the war effort.

Full Loading of Cars

You can also help in another way. There are many instances, I believe, where company material can be unloaded at a central place and sent either by truck or less than carload assignment to the various places it is needed, thus making it unnecessary to stall the way freight to unload part of a car.

This is well worth your consideration. Pay special attention, if you will, to the full carloading of your materials. Let it not be said that the shippers and the receivers of freight who pay us their good

money can do a better job than our railroad men when it comes to the full loading of cars. Nothing appears more tragic to the man who is trying to provide cars enough, or to the shipper who requires cars, than to observe a flat car or a gondola running across the country with perhaps two or three wheels on it. This may absorb for a week or two a first class 50-ft. flat car to transfer a few wheels from a storehouse to a particular roundhouse where they are needed. This is also true with respect to any small amount of material, which absorbs the use of flat cars or gondolas. Thus, perhaps you have deprived the people who are building tanks and jeeps and guns for at least a week of the use of that particular type of car.

Our supply of cars so far has been more or less adequate, although we own a considerably smaller number than we owned in 1929. We have on order 900 loco-

"There Appears to Be No Necessity for Any Road Holding Revenue Cars Under Load Longer Than the Free Time Given Receivers of Carload Traffic"



motives and 80,000 freight cars, but there is grave doubt whether we shall be able to get priorities for anywhere near such number of locomotives or cars. We are, therefore, faced with the prospect of handling this increased business, handling this great war load, both of men and materials, troops and supplies, with our present equipment.

I hope that our fears are never realized, because we need the 80,000 cars and we need the 900 locomotives on order. The locomotives are running faster, carrying heavier loads than they ever did. You will be interested to know that while carloadings themselves show an increase of only four or five per cent as compared with a year ago, the net ton-miles—which means the net tons of freight handled in a car multiplied by the number of miles it is hauled—have gone beyond any figure ever dreamed of, in fact, 50, 60, 70 per cent higher than four or five years ago, 40 per cent higher than last year. The cars are being loaded to capacity and they are being run more rapidly. If it were not for these two facts, our present equipment would be inadequate.

Use Available or Surplus Types

I want to speak about one other thing; that is, that the more essential equipment be conserved for the purpose for which it was intended. Therefore, you should never ask that material be loaded in open-top cars if box cars or stock cars can be used. In these days of war and a tense equipment situation, we should not require a steel mill or a lumber manufacturer or a man who makes chains,

angle bars or spikes to wait until a car of a particular type reaches his plant before he can load material. Also, when it comes to ordering ties and other materials which may be loaded in a box car, we should make our orders read that way. We all know that these materials will unload more readily from an open-top car than from a box car, but the matter of expense in the loading and the matter of expense in the unloading should go by the board. You are watched in your expenditures; we are all watched in our expenditures; but in these days, when we must have every open-top, every gondola and coal car—and every flat car for material which cannot be transported in a box car or a stock car, it is up to all of us to see that the purchasing agent is instructed, if he be the man, not to signify to the steel company, the lumber manufacturer, etc., the type of car that shall be used. Instead, he will urge, you will urge, and all those connected with the railroads must urge, that we use the type of equipment which is the least critical at the time. We must not use flat cars or gondolas if some other type of car is available.

DISCUSSION

President Dove: I wonder if Mr. Beck will answer some questions?

Mr. Beck: I will try, but I cannot promise to answer all of them.

Elmer T. Howson (Ry. Engr. & Mtce.): The point I am about to raise is not really a question, although it may lead to one. A word of commendation should certainly be given to Mr. Beck for the serv-

ice he has rendered. The shippers have given a challenge to railroad men in the use of cars. Mr. Beck has brought this challenge to us. When the shipper, the customer of the railroads, will organize vigilance committees to see that other shippers co-operate in utilizing equipment with maximum efficiency, this constitutes a challenge to every railroad man not only to do as well but to do better. The railroad man should really lead the way. Yet there are cases such as Mr. Beck has very tactfully touched on, cases which could be multiplied many times, in which railroad men have not yet grasped the message to the same extent as the shippers.

Co-operation of Shippers

To my mind, one of the great developments of the present car situation is the remarkable co-operation the shippers are extending to the railways. They are as alert, and, in many cases, even more alert than the railways in getting maximum service from railway equipment. This is an accomplishment in which the Association of American Railroads and the American railroads individually can take great pride, but every car held in company service for an unnecessary long period is an indictment of the railroads.

There are hundreds and thousands of shippers throughout this country who are disregarding expense to themselves in order to release equipment. They are paying overtime to their platform forces; they are working on Sundays and holidays to release equipment, so that they or other shippers may have that equipment available for immediate loading.

Then there is the further national emergency now. Our men are going into battle lines in large numbers, and modern warfare requires a tremendous amount of transportation. The railways must provide that transportation. If our men, wherever they are located, are going to have proper support, it is going to be because railroad men, with others, back them up by getting to them the material they need. In these days, every time a car with company material, particularly an open-top car, is held under load longer than is absolutely necessary, it is made unavailable for the handling of tanks and other material which needs to be moved to the front.

This is a challenge every one of us should take home, a challenge which the shippers have recognized, a challenge which many, but not all, railway men have recognized. We should go out of this meeting with a determination that every man in this room, and any man carrying responsibilities comparable to those of you men, will do his utmost to release cars.

It is no longer a question of cost. It is a question of keeping our railways from breaking down. They are making a remarkable record, but the demands are going to be even greater. We must continue to meet these demands even though new cars and new locomotives will be available only in very limited numbers.

We have been told during these three days that railway men are in the nation's service; that we are an arm of the military forces. If we are an arm of the military forces, as we know we are, we must meet our responsibilities as resolutely as the men in the field.

Mr. Beck has made a very real contribution to this meeting, and, as we say, the "bee" is on us now to deliver.

President Dove: Thank you, Mr. Howson. I think many of the railroads are already working on the idea of the full loading of cars. Word has been sent throughout our whole organization, and our store expense has gone up. This might be another indication that material is being loaded in box cars rather than in cars less difficult to load.

Maintenance Problems Different

Armstrong Chinn (Alton): I want to say a word in defense of the man on the railroad who is trying to get his material unloaded. On my road, I know that all of our men appreciate the necessity of unloading company material as rapidly as they can, and I know that they put in requests for train service whenever the material shows up, so that if the service is provided, they will unload the material within 24 hr., as Mr. Beck has suggested. Most of this material, however, is required out on the line away from stations, which means that while it is being unloaded, particularly on single track railroads, the line is blocked. We have a lot of fast freight trains operating these days and it is quite difficult at times to get time to unload this material out on the line. The superintendents, I feel certain, are well aware of the necessity of unloading company material promptly, and, during these times, are not particularly concerned about train expense and overtime. It is merely a question of whether they can block the railroad and possibly delay important freight

trains and passenger trains while this material is being unloaded.

I do not believe that railroad men will ever be able to make the showing which has been made by the shippers, because they have to unload their materials out on the line. If it were simply a matter of spotting the car at a station and getting the material on the ground, I think the railroad men could and would make as good a showing as the shippers, and possibly better, because they would have a gang right there when the car arrived. But since they have to unload it out on the line, at points away from stations, their difficulties are increased. The superintendent is not going to delay the movement of shipper goods so that a bridge and building supervisor or a roadmaster or a chief engineer can get his material on the ground.

W. A. Huckstep (M. P.): I have been waiting for someone to make such a defense. I think Mr. Beck has brought us a great challenge, which I know we will all strive to live up to. There is, however, another disadvantage, not mentioned by Mr. Chinn, which I think keeps the bridge and building man, more than anyone else, from making a showing. Most of his material is lumber, and lumber, as you know, is not evenly distributed over the country; some of it comes from great distances. When you figure this in days that cars are under load, you will find that much of the time has been consumed in the movement from point of loading, which is often 1,000 or 1,200 miles away. I think this puts the bridge and building man at a much greater disadvantage than men in other branches of the service.

G. S. Crites (B. & O.): I do not

believe the bridge and building men have ever been the people who say it can't be done. The handling of cars must be scheduled, especially for maintenance of way work. I will give you just one instance of scheduling cars. The car situation in my territory is critical, especially for coal hoppers. As we usually need stone ballast, we have arranged to sort out a particular type of hopper which will unload this ballast readily. Since the mines do not work on Saturday, we stop the cars we need for ballast on that day on their way to the mines, send them to a quarry and have them loaded with special stone which will flow readily. These cars move into the terminal on Saturday when we have the use of a locomotive, because we usually have a few surplus locomotives then. By this arrangement, we have been able to unload eight carloads of stone and eight carloads of cinders within eight hours and get the cars back to the mines on Monday morning.

Planning Important

As to the unloading of timber, if it is scheduled so as to be sent to a central point where it can be made up into a full car, you can often save many car-days in getting the timber out on the line. The whole proposition is simply one of planning, programming and scheduling the work; to keep closely in touch with your transportation officers, so as to be in a position to use the power and cars when they are available. But when you do get the power and the cars, they should be unloaded and put back into service immediately. It is not impossible; the bridge and building people have never been a force

to say anything is impossible. It can be done.

H. B. Christianson (C. M. St. P. & P.): I wish to say "amen" to what Mr. Crites has just said. With all due respect to the other two gentlemen, their statements were more or less in the nature of alibis. We are out to do a job and we can do it. For instance, speaking of our trains blocking the tracks, they block them only while they are doing the work, and then get back into town and out of the way. No railroad is so busy that it does not have a few minutes or a few hours in which to permit a crew to work. So, even though this may result in overtime and may take longer and cost more, we can get that material unloaded if we set out to do it.

Also, there are other ways of unloading materials than with work trains. In many instances it is possible to unload the material at stations and truck it out. It may cost more, but it is one way to avoid blocking the main track. I think, as Mr. Crites does, that we cannot offer alibis; we must go out and do the job.

Mr. Chinn: I was not offering an alibi, but merely trying to explain the situation. I am willing to offer Mr. Christianson some two-to-one money that his record for unloading cars is not as good as the shippers generally, not because he is not trying, but because the difficulties he encounters in getting his material unloaded are greater than those of the shipper.

As I said in the beginning, I think that every maintenance man, every bridge and building man, realizes the importance of unloading and releasing cars as promptly as possible. I agree that we should

make new studies and see what can be done to improve our record; I think it can be improved. But I do not think our record will ever be as good as that of the shippers, at least not until the maintenance man is given a work train when he asks for it to unload his material at a scheduled time and place.

Use Way Freight

Mr. Beck: I fully appreciate what has been said about getting an engine and a work train, but let us not lose sight of the fact that there are opportunities to unload this material from the way freight or from the switch train. In other words, let us face the situation as it exists. I have been a train dispatcher and a division superintendent, and I know that ordinarily when one of your foremen has material to unload, which can be handled by way freight, he either telegraphs the train dispatcher or, if he happens to be at headquarters, telephones him or goes to see him. The train dispatcher has many problems. If it should happen that the way freight put in a few hours overtime the day before, because of running into more work than was expected, the train dispatcher or trainmaster has had to explain why the overtime occurred. Consequently, the dispatcher may not feel any too happy when your foreman asks to have a carload of bridge timbers taken out to "A" and unloaded by the way freight. He will probably say, "No, we are not going to do it. We cannot do that without blocking the railroad and running into overtime. You will have to wait until we clean up a little more or perhaps get enough material to run a work train. Maybe we can give

you an engine next Saturday."

If this happens, do not let it rest there. In all probability, the superintendent has no knowledge of the situation. With all due respect to train dispatchers, because I know what they are up against, they are usually men of expediency. They have to keep the railroads open, and sometimes brush off these requests, and will not stop the way freight to unload material. The way freight goes in on time and thinks no more about it, but the foreman still has the material on hand. It has to be unloaded some time, so let us educate the foreman that, if and when he receives a rebuff from the train dispatcher, he should take his problem to the next man in authority, who should contact the superintendent.

The superintendent, if confronted with the figure of two or three cars of bridge timbers which have been delayed six days due to not having been unloaded at a point where needed, will sit up and take notice, because he knows that the shippers' vigilance committees are also watching company material.

If some of these shippers fail to get a gondola or a box car or a flat car and find 16 or 17 cars of scrap laying around in some yard because it was loaded before it was sold, they are going to say something about it, in fact, it will probably be reported to the president of the railroad. The foreman should, therefore, be educated to take his requests to someone higher in authority than the dispatcher, if he fails to get satisfactory service.

I know you are keyed up, all of you, and have your own problems,

but if a carload of ties remains unloaded, we are not going to move a car of shipper freight which should have gone in that particular car, had it been emptied. So let us keep the whole picture in mind. In spite of shortages here and there, unless we get in there and pitch, we are not going to operate our railroads efficiently, to the extent that will satisfy the Interstate Commerce Commission, the Office of Defense Transportation, the shippers or anybody else.

Mr. Chinn: I agree with all Mr. Beck has said, and on our road we are handling the problem in just that way. We recently had 16 cars of ballast to unload which had been set out at a station. As soon as the material arrived, the supervisor wired the dispatcher for a work train to unload it. The work train did not arrive and after waiting three days, he wired his division engineer, who went to the superintendent. The reason for not sending the work train the first day was that there was no power available. There was so much traffic on the division, they simply did not have an engine to give him. I do not know whether a local could have handled the ballast; I did not check that far, but I doubt that a local could have taken 16 cars out at that time.

I think, just as you state, that everyone has to have a greater appreciation of the necessity of getting this material on the ground as quickly as possible. When it comes to a question of delaying shipper material or delaying company material, we know which one must be delayed.

Mr. Christiamson: I agree with what has been said, that it is very difficult to get materials unloaded

and that it is sometimes impossible to get work train service. Many divisions do not have local trains and, therefore, do not have the opportunity of unloading materials with such service. We have been confronted with preemptory orders to get materials unloaded, and in many cases we have had to unload bridge material at terminals and later re-load it. This has cost quite a bit of money. Many times we have had to unload material which arrived without notice, with the result that we do not have a gang nearby and delay usually ensues. There are many kinds of complications, but the point I emphasize is that we must take whatever means we can to get the material off the cars.

We have no one solution for this problem with which we are all faced. I do not think we are doing as well as the shippers, but we are trying to do our best.

Mr. Chinn: I think what Mr. Christianson says is right; we must forget the expense and get the material on the ground. After all, we are using more expensive materials to do the work, because we cannot get the critical materials we would like to have. We must forget about getting what we want or doing what we would like to do, and merely take care of the situation as best we can, because, as has been so well said, "if we lose this war, nothing else will matter."

President Dove: Mr. Beck, we are indebted to you for coming here today to give us this message and for permitting the discussion following your address. I hope you will accept the thanks of this organization.

Highlights of Convention Reviewed

By Past-President A. E. Bechtelheimer
Bridge Engineer, Chicago & North Western



A. E. Bechtelheimer

This has been a very unusual meeting. The attendance has exceeded expectations, reaching 86 per cent of the attendance of last year, and the interest and enthusiasm shown have exceeded that at many of our former meetings.

Every activity has been keyed to the necessity of winning the war. We have been reminded by every speaker of the part the railways are playing to this end.

What we have gained from this meeting has come to us through sight, feeling and hearing. What we have heard will be recorded in our proceedings and will be passed along in due time to all concerned. What we have seen and felt will be retained in our memories and will be reflected in our daily work by the increased enthusiasm and interest with which we continue our duties in our respective jobs.

The last year has brought a succession of unpredictable happenings, in that so many of the things that we have been called upon to

do were unforeseen and unexpected. We are facing a continuation and surely an intensification of this same situation. Our association work will be affected during the continuation of the war.

A year ago, Armstrong Chinn, in summarizing the 1941 meeting, commented upon the fact that the association was ending its 50th year. This meeting marks the beginning of the second 50 years of our activity, and we must carry on with undiminished interest and enthusiasm. Just this morning a letter came to my desk from C. H. Buford of the Association of American Railroads in which he stated: "I do not think it will be necessary to forego any necessary association activities because much of our work can be handled by correspondence, and we want to handle it that way to the greatest extent possible." This seems to be an indication that it is expected that our association activities will be continued.

In reviewing the highpoints of our meeting, I want to refer first briefly to the part of our program that was contributed by men outside our association.

C. E. Johnston, chairman, Western Association of Railway Executives, and associate director, Western region, ODT, Chicago, opened our meeting, and in an inspiring address, reminded us that we live in the grandest country on earth, and pointed out the prob-

lems that confront us, the greatest of which, he said, is the Problem of Winning the War. He indicated that the contribution of the railways consists in supporting the production line and the service of supply. He left with us the statement that a railroad is no better than its track.

H. R. Clarke, president of the American Railway Engineering Association, and chief engineer maintenance of way, Chicago, Burlington & Quincy system, Chicago, brought greetings from his association and said that maintenance must go on; that we must have essential materials and an adequate supply of labor; that we must train new men; and that we must use our ingenuity and resourcefulness to the fullest extent as the pace becomes faster with constantly increasing demands. He reminded us that the normal maintenance and repair of our railroad plant is not unpatriotic, and urged that we go back to our work and do a better job.

Bringing greetings from his association, E. L. Banion, president of the Roadmasters' Association, and roadmaster on the Atchison, Topeka & Santa Fe, at Topeka, Kan., analyzed the problems confronting us from the standpoint of the man in the field, and cautioned that there must not be too much, too soon. In other words, that we must not hoard material.

On Tuesday afternoon, B. R. Kulp, chief engineer of the Chicago & North Western, Chicago, speaking on the Protection of Railway Structures in Time of War, reminded us that the disruption of even the smallest units of our transportation communication network might exert a strain upon

that system that would ultimately be felt thousands of miles away. He also reminded us that, in addition to the thousand and one things involved in our daily work, it is our responsibility to see that sabotage is not committed.

On Tuesday evening, W. G. Darley, illuminating engineer, Lamp Department, General Electric Company, gave us a very instructive and interesting address on the Problems of Protective and Black-out Lighting, and illustrated his remarks with lantern slides and a large array of special lighting equipment.

Addressing us on Wednesday morning, Edwin M. Fitch, assistant director, Division of Transport Personnel, ODT, Washington, D. C., gave us some interesting statistics on the distribution of the personnel in the bridge and building forces of the railways, and commented constructively on the question of the deferment of key men in railway service.

Critical Materials Discussed

Opening a symposium on Wednesday afternoon, on Critical Materials in Wartime for Bridge, Building and Water Service Work, David P. Beach, assistant chief, Maintenance Equipment Section, WPB, Washington, D. C., outlined the critical material situation and left the impression that we will face great difficulty in securing suitable and adequate materials for our routine maintenance work, and can probably secure no materials for rebuilding and new work, except insofar as materials for this work can be obtained from stocks on hand or through reclamation.

Mr. Beach's address was fol-

lowed by discussion on what We Can Do To Meet The Material Situation—by J. B. Hunley, engineer of structures, New York Central, Lines West of Buffalo, Chicago, who spoke for bridge men; by O. G. Wilbur, appraisal engineer, and until recently, field engineer, in the building department, Baltimore & Ohio, Baltimore, Md., who spoke from the standpoint of building men, and by G. E. Martin, superintendent of water supply, Illinois Central, Chicago, who spoke for water service men. These discussions were much to the point and made it clear that we must exercise all of our ingenuity and resourcefulness to meet our material requirements.

In another address on Wednesday afternoon, R. P. Hart, bridge engineer, Missouri Pacific, St. Louis, Mo., discussing the Possibilities for Reclamation and Salvage by the Bridge Forces, outlined the measures in this regard adopted on his road. He pointed out that railway men are, in effect, soldiers, and said that the success of a reclamation and salvage program depends upon the full cooperation of all railway employees.

On Thursday morning, W. D. Beck, district manager, Car Service division, AAR, Chicago, discussed the effect on the car supply occasioned by the transportation of company materials, and charged that, in general, company materials are not being unloaded as promptly as revenue loadings.

Budd Addressed Luncheon

This summary of the addresses would not be complete without mention of our annual luncheon on Wednesday, which was addressed by Ralph Budd, president of the

Chicago, Burlington & Quincy system. Speaking before approximately 300, which was a larger number than has attended this function in any previous year, Mr. Budd stated that the railways are a favored group in the war effort, a fact which carries with it great responsibilities. He urged that we do today the most that can be done to promote the war effort; and said that we should exercise care in the use of materials, without waste or hoarding. He expressed particular concern over the training of the new men who are necessary to maintain our working forces, and said that the question of safety must be stressed. He expressed confidence that the railways will continue to do their job if allowed to do so; also that we will get help when it is needed.

Eight Fine Reports

Supplementing this array of speakers, the program included eight committee reports, and it is no exaggeration to say that each of them was exceptionally good.

The report on Preventing Accidents, presented by E. H. Barnhart, division engineer, Baltimore & Ohio, Garrett, Ind., was comprehensive, authoritative, and in great detail; presenting information that can be readily understood and put into practice.

The report on the Cleaning of Masonry Buildings, presented by W. A. Huckstep, general building supervisor, Missouri Pacific, St. Louis, Mo., is a veritable textbook in which can be found the answers to all of our problems of this character.

The report on Increased Water Supplies for Fast Freight Service,

presented by J. P. Hanley, water service inspector, Illinois Central, Chicago, covers the subject fully, and the conclusions reached by the committee should be very helpful to water service men.

The report on Wearing surfaces for Building Floors, Platforms and Roadways, presented by T. H. Strate, division engineer, Chicago, Milwaukee, St. Paul & Pacific, Chicago, set forth information that amounts almost to specifications for all types of wearing surfaces in use on the railways.

The report on Conserving Bridge, Building and Water Service Materials, presented by F. G. Campbell, assistant chief engineer, Elgin, Joliet & Eastern, Joliet, Ill., is an important contribution to the theme that was dwelt on by nearly all of the men who addressed our sessions.

The report on Rail Fastenings on Bridges, Pits and Turntables, presented by J. S. Hancock, bridge engineer, Detroit, Toledo & Ironton, Dearborn, Mich., set forth in great detail the practices of many railroads in this regard, and merits careful study when we are searching for the solution of our problems relating to rail fastenings.

The report on the Repair of Steel Bridges, presented by A. R. Harris, assistant bridge engineer, Chicago & North Western, Chicago, is, I believe, the first report on this subject that has been considered by our Association. It is

particularly timely and should be of great assistance in connection with the maintenance of our steel structures, especially at this time when new bridge materials cannot be obtained.

And finally, the report on Piles and Pile Driving, presented by W. F. Martens, general foreman, bridge, building and water service, Atchison, Topeka & Santa Fe, San Bernardino, Cal., really hit the bull's-eye. In my hurried perusal of this report, I found much information that will be very helpful to me, and I am sure that it will be equally helpful to others.

The only moments of relaxation in the long and intensive program of the meeting were experienced on Wednesday evening, with an informal dinner, following which, Sam Campbell, Naturalist, presented an interesting and entertaining illustrated lecture on what he terms his Scrap Book of the West. More specifically, the lecture and pictures covered wild life in Northern Wisconsin and a scenic trip through the Pacific West and Southwest.

Indeed, this has been a most unusual meeting. Surely the problems facing us at this moment are as acute and difficult as those that faced the men who were instrumental in bringing this association into being. Therefore, we must guard against any slackening of our interest, enthusiasm and ardor in its behalf.

MEMBERS REGISTERED AT THE 1942 CONVENTION

Altogether, 234 members and guests from roads widely scattered over the United States registered their attendance and took part in the convention. Following is a list of members who registered:

Aagaard, Peter	Elmquist, F. G.	*Lehon, Tom
Anderson, R. D.	Engman, V. E.	Linn, G. A.
Anderson, W. L.	Evans, L. I.	Livingston, H. T.
*Austin, Paul R.	*Filkins, A. J.	Lodeski, J. B.
*Baker, Ralph D.	Firehammer, L. M.	Luce, W. L.
Bardill, M. L.	Frisbie, A. H.	Luck, Richard P.
Bardwell, R. C.	Garis, L. D.	Lyman, C. R.
*Barham, R. Y.	Gehr, B. F.	Madson, Howard C.
Barnhart, E. H.	Hadwen, L. D.	Maisenbacher, P. F.
*Batchelder, K. T.	*Hall, E. B., Jr.	Manning, Daniel A.
Batey, W. A.	Hancock, John S.	Martens, W. F.
Bear, Maxfield	Hanley, J. P.	Martin, Guy E.
Bechtelheimer, A. E.	Harlow, A. W.	Masters, F. H.
Benson, G. W.	Harris, A. R.	Matthews, A. N.
Beringer, M. A.	Hayes, John W.	McCloy, A. L.
Boales, John A.	Hillman, A. B.	Merwin, Paul B.
Bost, M. A.	Hillman, F. W.	Meyer, M.
Boyd, George E.	Hinsch, L. C.	Montzheimer, A.
Brown, W. H.	Holmberg, V. V.	Miller, M. D.
Burpee, C. Miles	Holmes, G. H.	Richards, C. A. J.
Butts, B. L.	Howard, Neal D.	Roof, Walter R.
Byrd, L. G.	Howay, B. J.	Sheehy, Thomas J.
Campbell, F. G.	Howson, Elmer T.	Sirel, Alex A.
Carothers, M. D.	Huckstep, W. A.	Smith, Leo C.
Caudle, R. E.	Huffman, W. H.	Soothill, F. H.
Chamberlain, P. C.	Huntoon, J. S.	Stice, J. G.
Chapman, A. B.	Johnson, Maro	Strate, T. H.
Chinn, Armstrong	Johnston, C. E.	Taggart, F. E.
Christianson, H. B.	Johnston, G. H.	Thompson, L. R.
Church, H. M.	*Keith, Laurence P.	Tratman, E. E. R.
Clark, K. L.	Kimball, L. P.	Vandenburgh, E. C.
Coffey, Glen V.	Knight, S. H.	Varker, J. L.
Cook, R. W.	Knowles, A. M.	Vreeland, J. S.
Corey, S. T.	Knowles, C. R.	Wall, E. G.
Crites, G. S.	Kulp, B. R.	Weise, F. E.
Day, E. G.	Kvenberg, S. E.	Whitehouse, B. M.
Dayton, Frank W.	Lacher, W. S.	Williams, C. A.
Dorland, A. G.	Lacy, W. J.	Winkelhaus, L. C.
Dove, R. E.	Landstrom, C. A.	Yates, D. C., Jr.
Duresky, F., Jr.	Leak, Virgil	

*Associate Member

	1891-2	1892-3	1893-4	1894-5
President.....	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st V.-Pres....	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd V.-Pres....	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd V.-Pres....	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th V.-Pres....	G. W. Hinman	C. T. Fuller	E. D. Hines	Walter G. Berg
Secretary.....	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer.....	George M. Reid	George M. Reid	George M. Reid	George M. Reid
Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
	W. A. McGonagle	J. M. Caldwell	Floyd Ingram	J. H. Cummin
	G. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895-6	1896-7	1897-8	1898-9
President.....	W. A. McGonagle	James Stannard	Walter G. Berg	J. M. Cummin
1st V.-Pres....	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
2nd V.-Pres....	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard
3rd V.-Pres....	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers
4th V.-Pres....	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten
Secretary.....	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer.....	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	J. L. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Hefflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President.....	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres....	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres....	J. M. Staten	B. F. Pickering	A. Shane	A. Shane
3rd V.-Pres....	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres....	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary.....	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer.....	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	T. M. Strain	T. M. Strain	A. Montzheimer	W. E. Smith
	R. L. Hefflin	H. D. Cleaveland	W. E. Smith	A. W. Merrick
	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President.....	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres....	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd V.-Pres....	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres....	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres....	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary.....	S. F. Patterson	S. F. Patterson	S. P. Patterson	S. F. Patterson
Treasurer.....	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	H. H. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	b. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President.....	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres....	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres....	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres....	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres....	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary.....	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer.....	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
	J. S. Lemond	Willard Beahan	F. B. Scheetz	J. Aldrich
	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President.....	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres....	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres....	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres....	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres....	T. J. Fullem	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary.....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer.....	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	W. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President.....	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres....	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres....	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres....	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres....	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President.....	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres....	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres....	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres....	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres....	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.....	J. P. Wood	C. W. Wright	F. E. Weise	F. E. Weise
Directors	A. B. McVay	A. B. McVay	E. T. Howson	F. C. Baluss
	J. H. Johnston	G. A. Manthey	J. H. Johnston	Maro Johnson
	E. T. Howson	E. T. Howson	E. K. Barrett	O. F. Dalstrom
	C. W. Wright	J. H. Johnston	F. C. Baluss	S. D. Corey
	G. A. Manthey	E. K. Barrett	Maro Johnson	W. B. Hotson
			O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President.....	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres....	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres....	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres....	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres....	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.....	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President.....	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres....	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres....	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres....	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres....	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.....	F. E. Weise	F. E. Weise	G. A. Rodman	E. C. Neville
Directors	W. T. Krausch	R. C. Henderson	W. A. Batey	H. H. Best
	R. C. Bardwell	J. S. Ekey	F. W. Hillman	J. E. King
	H. I. Benjamin	T. H. Strate	E. C. Neville	A. B. Scowden
	R. C. Henderson	G. A. Rodman	H. H. Best	W. A. Batey
	T. H. Strate	W. A. Batey	J. E. King	L. C. Smith
	J. S. Ekey	F. W. Hillman		

	1934-1935	1935-1936	1936-1937	1937-1938
President.....	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres....	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres....	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres....	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres....	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas....	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCloy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938-1939	1939-1940	1940-1941	1941-1942
President.....	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres....	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres....	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres....	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres....	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas....	C. A. Lichty	C. A. Lichty		
Secretary.....			F. O. Whiteman	A. G. Shaver
Treasurer.....			F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942-1943	1943-1944	1944-1945	1945-1946
President.....	G. S. Crites			
1st V.-Pres.....	R. E. Caudle			
2nd V.-Pres.....	A. M. Knowles			
3rd V.-Pres.....	N. D. Howard			
4th V.-Pres.....	J. L. Varker			
Secretary.....	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern			
Treasurer	F. E. Weise			
Directors	M. Meyer			
	L. E. Peyser			
	K. L. Miner			
	F. G. Campbell			
	J. S. Hancock L. C. Winkelhaus			

†To November 1, 1942

‡To February 1, 1943

NEW MEMBERS

Autcliff, R. A.
 Bardill, M. L.
 Borchert, W. C.
 Broderick, D. T.
 Brown, W. H.
 Burkey, J. R.
 Clancy, M. A.
 Coffey, G. V.
 Creedle, Fred
 Cummins, R. A.
 Curie, H. D.
 Davis, G. B.
 Dick, H. M.
 Duresky, Frank, Jr.
 Elfstrom, Paul
 Flessa, J. F.
 Frazin, A.
 Hall, E. B., Jr.—Associate
 Hayes, J. W.

Hillman, A. B.
 Holmberg, V. V.
 Hornung, K. E.
 Johnson, A. W.
 Johnston, Guy H.
 Kearfott, W. E.
 Kelly, R. D.
 Klingel, T. R.
 Knapp, Paul
 Lang, H. A.
 Lewis, J. A.
 Martin, G. E.
 Matthews, A. N.
 Meeks, W. R.
 Moore, E. W.
 Mottier, C. H.
 Nicholson, C. P.
 Rose, A. G.
 Sathre, C. O.

Schaeperklaus, L. H.
 Schmaltz, E. F.
 Showalter, J. R.
 Smith, A. P.
 Smith, H. E.
 Smith, Leo C.
 Stern, I. F.
 Thompson, L. R.
 Thurman, S. R.
 Todd, D. Clinton D.
 Tupper, A. E.
 Veith, H. L.
 Wagner, S. P.
 Wall, E. G.
 Wallace, C. D.
 Walsh, J. J.
 White, Shirley

LIST OF ANNUAL CONVENTIONS

No.	Place	Date	Membership	Enrollment
1	St. Louis, Mo.,	Sept. 25, 1891	60	...
2	Cincinnati, Ohio,	Oct. 18-19, 1892	112	24
3	Philadelphia, Pa.,	Oct. 17-19, 1893	128	27
4	Kansas City, Mo.,	Oct. 16-18, 1894	115	38
5	New Orleans, La.,	Oct. 15-16, 1895	122	40
6	Chicago, Ill.,	Oct. 20-22, 1896	140	36
7	Denver, Colo.,	Oct. 19-21, 1897	127	43
8	Richmond, Va.,	Oct. 18-19, 1898	148	34
9	Detroit, Mich.,	Oct. 17-18, 1899	148	32
10	St. Louis, Mo.,	Oct. 16-18, 1900	143	45
11	Atlanta, Ga.,	Oct. 15-17, 1901	171	46
12	Minneapolis, Minn.,	Oct. 21-23, 1902	195	52
13	Quebec, Canada,	Oct. 20-22, 1903	223	65
14	Chicago, Ill.,	Oct. 18-20, 1904	293	104
15	Pittsburgh, Pa.,	Oct. 17-19, 1905	313	62
16	Boston, Mass.,	Oct. 16-18, 1906	340	81
17	Milwaukee, Wis.,	Oct. 15-17, 1907	341	91
18	Washington, D. C.,	Oct. 20-22, 1908	368	99
19	Jacksonville, Fla.,	Oct. 19-21, 1909	393	79
20	Denver, Colo.,	Oct. 18-20, 1910	428	117
21	St. Louis, Mo.,	Oct. 17-19, 1911	499	102
22	Baltimore, Md.,	Oct. 15-17, 1912	524	103
23	Montreal, Que.,	Oct. 21-23, 1913	570	100
24	Los Angeles, Cal.,	Oct. 20-22, 1914	586	126
25	Detroit, Mich.,	Oct. 19-21, 1915	665	159
26	New Orleans, La.,	Oct. 17-19, 1916	710	154
27	Chicago, Ill.,	Oct. 16-18, 1917	704	168
28	Chicago, Ill.,	Oct. 15-17, 1918	716	119
29	Cleveland, O.,	Oct. 21-23, 1919	776	196
30	Atlanta, Ga.,	Oct. 26-28, 1920	840	172
31	New York, N. Y.,	Oct. 18-20, 1921	850	207
32	Cincinnati, Ohio,	Oct. 17-19, 1922	865	167
33	Seattle, Wash.,	Oct. 16-18, 1923	846	140
34	Kansas City, Mo.,	Oct. 21-23, 1924	837	202
35	Buffalo, N. Y.,	Oct. 20-22, 1925	759	172
36	Richmond, Va.,	Oct. 12-14, 1926	750	155
37	Minneapolis, Minn.,	Oct. 18-20, 1927	754	224
38	Boston, Mass.,	Oct. 23-25, 1928	755	211
39	New Orleans, La.,	Oct. 15-17, 1929	755	200
40	Louisville, Ky.,	Oct. 21-23, 1930	713	147
41	Chicago, Ill.,	Oct. 16-18, 1934	592	153
42	Chicago, Ill.,	Oct. 15-17, 1935	547	139
43	Chicago, Ill.,	Oct. 20-22, 1936	588	129
44	Chicago, Ill.,	Oct. 19-21, 1937	566	147
45	Chicago, Ill.,	Oct. 18-20, 1938	589	139
46	Chicago, Ill.,	Oct. 17-19, 1939	546	145
47	Chicago, Ill.,	Oct. 15-17, 1940	610	167
48	Chicago, Ill.,	Oct. 14-16, 1941	594	141
49	Chicago, Ill.,	Oct. 20-22, 1942	618	119

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1. The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings and other structures, by investigation, reports and discussions.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1. The membership of this association shall be divided into five classes, viz: Members, life members, associate, honorary and junior members.*

Section 2. A member shall be a person in a responsible position in connection with railway bridge and building work, or in the employ of a public regulatory body, a professor of engineering in a college, an engineering editor, or a government or private timber expert. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3. To be eligible for a life membership a member must have belonged to the association for at least ten years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of active membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2, of this Article.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members present at a regular meeting. They shall have all the rights of active members except that of holding office and shall be exempt from the payment of dues.

*Amended October 16, 1941.

Section 6. A junior member shall be a person who is a graduate of a recognized engineering school, or who has been employed for at least two years in the design, maintenance or construction of railway bridges, buildings or structures. Applicants shall be at least 21 years of age and they shall be elected in the manner prescribed for members, in Section 2 of this article. Juniors shall have all the rights of members except that of holding office. When the attainments of a Junior are such as to qualify him as a member, he may apply for promotion and the Executive Committee shall authorize such promotion when qualifications warrant the action. Unless a Junior is promoted, his membership shall cease automatically when he becomes 28 years of age.*

Section 7. Any member guilty of conduct unbecoming a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 8. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 9. Only active members shall hold office in this association, and only active and life members shall be entitled to vote in the election of officers or selection of place for holding annual convention.

ARTICLE IV.

OFFICERS

Section 1. The officers of this association shall be a president, four vice-presidents, a secretary, a treasurer and six directors who with the most recent past president shall constitute the executive committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members, shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1. The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association but shall not have the power to render the association liable for any debt beyond the amount then in the treasury and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE

Section 1. Except as otherwise provided the officers shall be elected at the regular annual meeting of the association and the election shall not

*Amended October 16, 1941.

be postponed except by unanimous consent of the members present at said annual meeting. The election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

Section 2.† The president, four vice-presidents, secretary and treasurer shall hold office for one year and the directors for two years, three directors being elected each year. All officers retain their offices until their successors are elected and installed.

Section 3.† The term of office of the secretary and the treasurer may be terminated at any time by a two-thirds vote of the executive committee. Their compensation shall be fixed by a majority vote of the executive committee.

The secretary shall also serve as secretary of the executive committee.

Section 4. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the executive committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1.† Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the executive committee.

ARTICLE VIII.*

LOCAL SECTIONS

Section 1. Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing but may receive others into affiliate membership. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee of the association approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

BY-LAWS

TIME OF MEETING

1. The regular meeting of this association shall convene annually on the third Tuesday in October at 10 a. m.

PLACE OF MEETING

2. The place of holding the next annual convention shall be selected by ballot at the annual meeting of the association. All the places proposed

†Amended October 17, 1940.

*Article adopted 1922.

shall be submitted to a ballot vote of the members present at the annual business session and the place receiving a majority of all votes cast shall be declared the location of the next annual meeting. If no place receives a majority of the votes cast, the place receiving the lowest number of votes shall be dropped on each subsequent ballot until a place is chosen.

3. It shall lie within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

DUES

5. The annual dues, for the fiscal year ending September 30, and payable in advance, shall be as follows:*

Members, \$4.00; Associate Members, \$3.00; Junior Members, \$2.00.

DUTIES OF OFFICERS

6.† The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8.‡ The secretary shall have the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.‡ The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10. After each annual meeting the president shall appoint a committee of five members, not officers of the association, of whom two at least shall be past presidents, and two of whom shall have served on the committee the previous year, which shall prepare a list of names of nominees for officers to be voted on at the next annual convention, in accordance with Article VI of the constitution, said list to be read at the first session of the second day of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee

*Amended October 16, 1941.

†Amended October 17, 1940.

‡Adopted October 17, 1940.

of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to cooperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS

- 15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Selection of place for next annual meeting.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise all discussions shall be governed by Robert's rules of order.

†Amended October 17, 1940.

DIRECTORY OF MEMBERS

As of July 31, 1943

- Aggaard, P., 6826 S. Dante Ave., Chicago (retired).
Aaron, H. C., Supv., B. & B., W. M. Ry., Cumberland, Md.
Adkins, H. O., Mast. Carp., D. & R. G. W. R. R., Grand Junction, Colo.
Ailes, Newton C., 64 Adams Place, Delmar, N. Y. (retired).
Aldrich, L. G., Br. For., N. Y. N. H. & H. R. R., South Braintree, Mass.
Alexander, L. B., Ch. Dftsman., M. C. R. R., Detroit, Mich.
Allen, G. A., Br. Inspr., C. & O. Ry., Clifton Forge, Va.
Allen, T. H., Supv. B. & B., C. & O. Ry., Hinton, W. Va.
Anderson, August, Gen. For. B. & B., L. S. & I. Ry., Marquette, Mich. (retired).
Anderson, G. F., For. B. & B., Sou. Pac. Co., Roseville, Cal.
Anderson, J. L., Supv. B. & B., M. P. R. R., Osawatomie, Kans.
Anderson, R. D., Div. Engr., C. & N. W. Ry., Huron, S. D.
Anderson, W. L., Office Engr., C. & N. W. Ry., Chicago.
Autcliff, R. L., B. & B. For., P. M., Edmore, Mich.
Azer, Wm. J., Asst. Supv., B. & B., C. & N. W. Ry., West Chicago, Ill. (retired).

Baker, F. A., Asst. Gen. Mgr., S. P., Los Angeles, Cal.
Baker, R. C., Supv. B. & B., C. & E. I. Ry., Danville, Ill.
Baker, W. L., Br. Inspr., C. & E. I. Ry., Salem, Ill.
Ball, H. H., Foreman, Can. Nat. Rys., Toronto, Ont.
Bardill, M. L., Asst. Engr., C. M. St. P. & P., Savanna, Ill.
Bardwell, R. C., Supt. W. S., C. & O. Ry., Richmond, Va.
Barnhart, E. H., Div. Engr., B. & O., Garrett, Ind.
Barr, H. L., Div. Engr., C. & N. W. Ry., Chadron, Neb.
Bartlett, J. F., Asst. Engr., C. & N. W. Ry., Escanaba, Mich.
Bateman, S. E., For. W. S., Mo. Pac. R. R., Poplar Bluff, Mo.
Batey, W. A., Const. Engr., U. P. R. R., Omaha, Neb.
Bear, Maxfield, Ch. Conc. Insp., C. & N. W. Ry., Chicago.
Beaver, J. F., Rdm., Sou. Ry., Greenville, S. C.
Bechtelheimer, A. E., Engr. Br., C. & N. W. Ry.,—C. St. P. M. & O., Chicago.
Begeman, W. H., Asst. Supv. B. & B., M. P. R. R., Falls City, Neb.
Benjamin, H. I., V. Chm. Sys. Ins. Com., S. P. Co., San Francisco, Cal.
Bennett, H. F., Asst. Mast. Carp., Erie R. R., Binghamton, N. Y.
Benson, G. W., Supv. B. & B., C. of Ga. Ry., Macon, Ga.
Beringer, M. A., Brg. Insp., I. C. R. R., Chicago.
Bird, H. F., Supv., B. & B., N. Y. C., Syracuse, N. Y.
Bird, J. E., Asst. Supv. B. & B., N. Y. C. R. R., Corning, N. Y.
Bird, W. D., G. F. B. & B., Santa Fe Ry., Albuquerque, N. M.
Bishop, H. T., Asst. Supv., B. & B., C. & O. Ry., Richmond, Va.
Blewer, E. H., Chainman, N. Y. C. R. R., Albany, N. Y.
Boales, J. A., Gen. Br. For., T. P. & W. R. R., Peoria, Ill.
Bolmgren, E. W., Div. Engr., C. M. St. P. & P., LaCrosse, Wis.
Borchert, W. C., Div. Engr., L. & A. Ry., Shreveport, La.
Bost, M. A., Asst. Engr., C. M. St. P. & P. R. R., Mason City, Ia.
Bouton, C. A., B. & B. Inspr., N. Y. C. R. R., Ravena, N. Y.
Boyce, C. W., For., B. & B., Y. & M. V. R. R., Vicksburg, Miss.
Boyd, G. E., Asso. Ed., Ry. Eng. & Mtce., 105 W. Adams St., Chicago.
Bradish, H. G., Transitman, N. Y. C. R. R., Albany, N. Y.
Brandt, J. H., Supv. B. & B., C. & O. Ry., Columbus, O.
Brie, Fred, 2418 Casper Ave., Detroit, Mich. (retired).
Broderick, D. T., Br. Insp., Nickel Plate R. R., Conneaut, Ohio.
Brokaw, Van S., Asst. Engr., C. M. St. P. & P. R. R., Chicago (U. S. Military Service).
Brown, Ira L., G. F. B. & B., A. T. & S. F. Ry., Arkansas City, Kan.
Brown, W. H., Mast. Carp., Alton R. R., Bloomington, Ill.

- Buckingham, W., 907 Chittock Ave., Jackson, Mich. (retired).
 Buckley, N. J., Supv. B. & B., I. & G. N., Palestine, Tex.
 Budd, Ralph, President, C. B. & Q. R. R., Chicago.
 Budzenski, F. N., Asst. Supv. B. & B., C. & N. W. Ry., Antigo, Wis.
 Buell, H. M., 3261 Farnain St., Omaha, Neb. (retired).
 Bugg, J. H., 363 Chesapeake St., London, Ont. (retired).
 Bulger, J. M., Brg. For. B. & B., Sou. Pac. Co., Martinez, Calif.
 Bunge, W. H., Asst. Engr., I. G. N., Houston, Tex.
 Burkey, J. R., Cons. Engr., Union Metal Mfg. Co., Canton, Ohio.
 Burns, R. T., Supv. W. S., C. & N. W. Ry., Boone, Iowa.
 Burpee, C. M., Mgr. Ed., Ry. Eng. & Mtce. Cyc., 105 W. Adams, Chicago.
 Butts, B. L., Mast. Carp., Erie R. R., Buffalo, N. Y.
 Byrd, L. G., Supv. B. & B., Mo. Pac. R. R., Poplar Bluff, Mo.
- Caines, W. W., Asst. Supv., B. & B., C. & O., Clifton Forge, Va.
 Caldwell, J. M., C. I. & L. Ry., Crawfordsville, Ind. (retired).
 Campbell, F. G., Asst. Ch. Engr., E. J. & E. Ry., Joliet, Ill.
 Campbell, L. B., Mast. Carp., D. & R. G. W., Grand Junction, Colo.
 Canty, J. P., Asst. to E. M. W., B. & M. R. R., Boston, Mass.
 Carothers, M. D., Ch. Engr., Alton R. R., Chicago.
 Cary, B. F., Supv. B. & B., Sou. Ry., Alexandria, Va.
 Cassidy, R. W., Asst. Cost Engr., C. & O. Ry., Richmond, Va.
 Castle, Lynn, B. & B. For., C. M. St. P. & P. R. R., Minneapolis, Minn.
 Caudle, R. E., Asst. Engr. Strs., Mo. Pac. Lines, Houston, Tex.
 Causey, A. E., Mast. Carp., C. R. I. & P. Ry., Dalhart, Tex.
 Chamberlain, P. C., Brg. Insp., Erie, Port Jervis, N. Y.
 Chamberlin, B. J., Scale Supv., C. & E. I. Ry., Danville, Ill.
 Chapman, A. B., Br. Engr., C. M. St. P. & P., Chicago.
 Chinn, Armstrong, Gen. Mgr., Alton R. R., Chicago.
 Christiansen, L., For. B. & B., C. M. St. P. & P. R. R., Marion, Ia.
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 Clark, K. L., Div. Engr., C. M. St. P. & P. Ry., Aberdeen, S. D.
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 Cramer, F. H., Brg. Engr., C. B. & Q. R. R., Chicago.
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 Elmquist, F. G., Brg. Insp., C. M. St. P. & P. R. R., Chicago.
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 Erickson, J. M., Supv. B. & B., A. A. R. R., Owosso, Mich.
 Ettinger, C., I. C. R. R., Chicago (retired).
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 Firehammer, L. M., Genl. Supv. B. & B., Ill. Term. R. R., Springfield, Ill.
 Flessa, T. J., B. & B. For., M. P., Sedalia, Mo.
 Flynn, M. J., C. & N. W. Ry., Chicago (retired).
 Fobes, E. E., Asst. Supr., B. & B., N. Y. C. R. R., Albany, N. Y.
 Fontaine, W. L., Br. For., N. Y., N. H. & H. R. R., Readville, Mass.
 Fournier, S. D., Brg. Insp., P. M. Ry., Detroit, Mich.
 Fox, R. L., Rdm., Sou. Ry., Alexandria, Va.
 Francis, B. J., Supv. B. & B., N. Y. C., Jersey Shore, Pa.
 Frazin, A., Engr., Drftsmn., C. & N. W. R. R., Chicago.
 Friets, C. G., Asst. Supt. B. & B., C. & N. W. Ry., Milwaukee, Wis.
 Friebie, A. H., For. W. S. C. & N. W. Ry., Sioux City, Iowa.
 Frost, L. M., Supv. B. & B., G. T. W. R. R., Battle Creek, Mich.

- Ganser, W. R., Mast. Carp., P. R. R., Jersey City, N. J.
 Garis, L. D., Asst. Gen. Brg. Insp., C. & N. W. Ry., Chicago.
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 Gerske, Aug., 2891 Hillside Drive, Burlingame, Cal.
 Gerst, H. A., Asst. Engr., G. N. Ry., St. Paul, Minn.
 Geyer, C. J., Gen. Mgr., C. & O. Ry., Richmond, Va.
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 Gillette, J. E., Carp. For., C. M. St. P. & P. R. R., Mazomanie, Wis.
 Gillis, A. D., Supv. B. & B., N. Y. N. H. & H. R. R., Providence, R. I.
 Ginter, F. M., For. W. S., Alton R. R., Bloomington, Ill.
 Giusto, Peter, Sou. Pac. Co., San Francisco, Cal. (retired).
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 Gooch, C. W., 1325 W. 9th St., Des Moines, Iowa.
 Goodwin, B. H., Supv. B. & B., Sou. Ry., Atlanta, Ga.
 Gove, E. T., Asst. Engr., C. N. R., Toronto, Ont.
 Gram, Eric, Asst. B. & B. Supv., S. P., Norden, Cal.
 Griffith, J. E., Supv., Sou., Keysville, Va.
 Grim, J. N., Div. Engr., N. Y. C. R. R., New York City.
 Gunderson, Ed., Supv. B. & B., C. St. P. M. & O., Altoona, Wis.
 Guppy, B. W., Engr., Structures, B. & M. R. R., Boston, Mass.
 Guyton, S. W., Mast. Carp., P. R. R., Cincinnati, Ohio (retired).
- Hadwen, L. D., C. M. St. P. & P., 1120 N. LaSalle St., Chicago (retired).
 Hallock, Knight, Supv. B. & B., C. & N. W. Ry., Pierre, S. D.
 Hampton, H. A., Div. Engr., Sou. Pac. Co., Portland, Oregon.
 Hancock, J. S., Brg. Engr., D. T. & I. R. R., Dearborn, Mich.
 Hand, Geo. W., Asst. to Ch. Ex. Off., C. & N. W. Ry., Chicago.
 Hanley, J. P., W. S. Insp., I. C. R. R., Chicago.
 Hansen, W. J., Gen. For. B. & B., D. & M. Ry., E. Tawas, Mich.
 Hanson, A., Supv., N. P. Ry., Missoula, Mont.
 Hanson, D. M., Asst. B. & B. For., M. P. R. R., Kansas City, Mo.
Harbor, J. F., Supv. B. & B., S. P. Co., Oakland, Cal.
 Harden, J. L., Supv. B. & B., M. C. R. R., Jackson, Mich.
 Harding, C. R., Asst. to Pres., S. P. Co., San Francisco, Calif.
 Harlow, A. W., Mast. Carp., Erie R. R., Huntington, Ind.
 Harlow, H. M., Asst. Gen. Supv. B. & B., C. & O. Ry., Richmond, Va.
 Harman, Wm. C., Supv. B. & B., Sou. Pac. Co., San Francisco, Calif.
 Harp, M. J., Asst. Supv. B. & B., Mo. Pac. R. R., Falls City, Neb.
 Harris, A. R., Asst. Engr. Br., C. & N. W.-C. St. P. M. & O., Chicago.
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Exclusive F-M Pump Design Assures Reliability, Power Saving

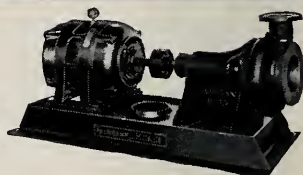
EACH Fairbanks-Morse pump is built with one idea in mind—reliability and economy. The motor is specially designed to work with the pump, and the pump to work with the motor.

In fact, Fairbanks-Morse is the only company to manufacture *both* pump and motor. This exclusive designing results in a closely integrated unit that gives rugged, dependable service.

This design is also responsible for remarkable savings in power costs. Tests have shown that ten-year old pumps, even if as good as new, use up to 25% more power than today's modern Fairbanks-Morse models. Many railroad men report that an F-M pump soon pays for itself with these savings.

Railroad men also appreciate the special service of the Railroad Division of Fairbanks-Morse. For the railroads are not just another customer—their service receives the attention of a special staff of engineers trained in railroad problems.

One of these engineers gladly will make an inspection of your pump needs without obligation or cost. Fairbanks, Morse & Co., Railroad Division, 600 S. Michigan Ave., Chicago. Branch offices with service stations throughout the United States and Canada.



5530—General Purpose Base-Mounted Centrifugal Pump.



5810—Split-Case Centrifugal Pump for handling clear water.



5430 (above)—Sewage and Trash Centrifugal Pump.



6920 (right)—Deep Well Turbine Pump.



5550—General Service Built-together Centrifugal Pump.

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DIESEL ENGINES ELECTRICAL MACHINERY RAILROAD EQUIPMENT WASHERS-IRONERS STOKERS
MOTORS FAIRBANKS SCALES WATER SYSTEMS FARM EQUIPMENT AIR CONDITIONERS



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• Oxy-acetylene flame-cleaning preparatory to the painting of bridges, tanks, cars, coaches, and many other types of steel structures is being used increasingly. This effective procedure quickly removes loose paint, scale, and rust from steel surfaces, and at

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THE OXWELD RAILROAD SERVICE COMPANY
Unit of Union Carbide and Carbon Corporation
Carbide and Carbon Building  Chicago
and New York



SINCE 1912 THE COMPLETE OXY-ACETYLENE SERVICE FOR AMERICAN RAILROADS

The word "Oxweld" is a registered trade-mark.

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for increased strength and rigidity
lower maintenance costs.

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Stronger Joints
Less Material



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PARTNER**
of the Railroads

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wide variety of structures—buildings, turntables, subways, viaducts and modern bridges.

We are glad to have had a part in projects which contribute so greatly to the wartime usefulness of the railroads. And we look forward to the time of peace when all our resources will again stand ready to serve the railroads in meeting their post-war tasks and responsibilities.

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consider the advantages of
**PRESSURE-TREATED
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Pressure-Treated Timber resists decay—termite attack—marine borers—fire. It is economical and easy to install. It does not spall or corrode.

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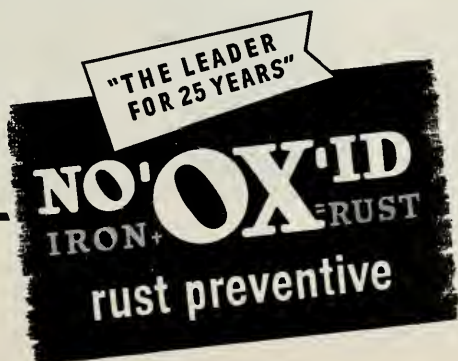
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Top: The "OVERHEAD DOOR" with built-in pass door, in an engine repair shed.

Right: Large, electrically operated "OVERHEAD DOORS" in a freight terminal.



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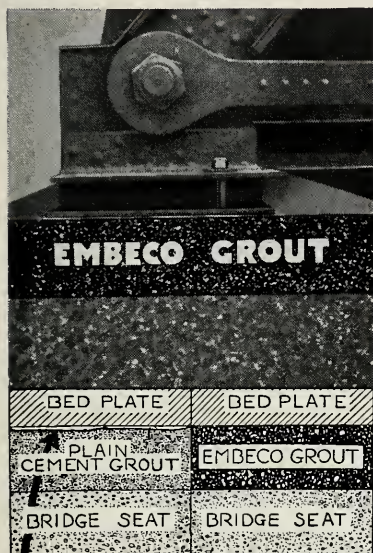
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Non-Shrink Embeco has no equal for *Speed* and *Permanence* in such operations as . . .



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The steel work of this bridge has the lasting protection of Bitumastic Super-Service Black.

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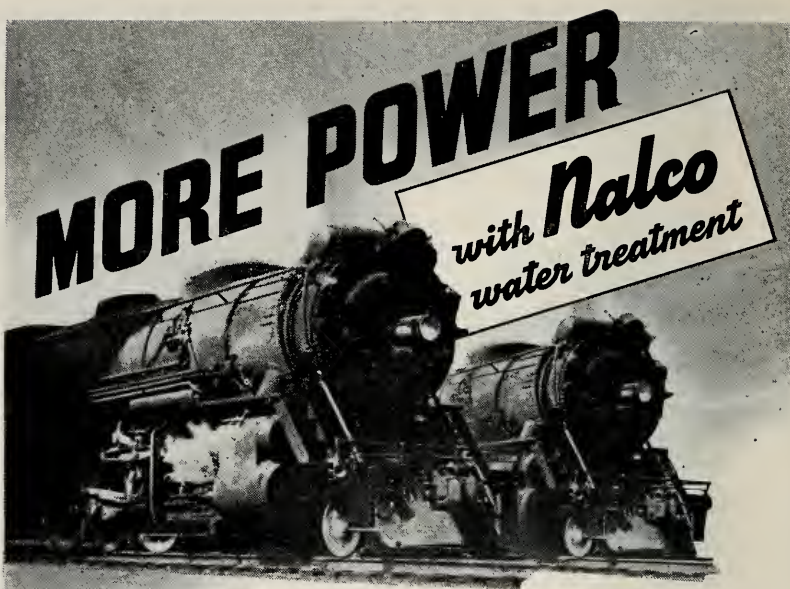
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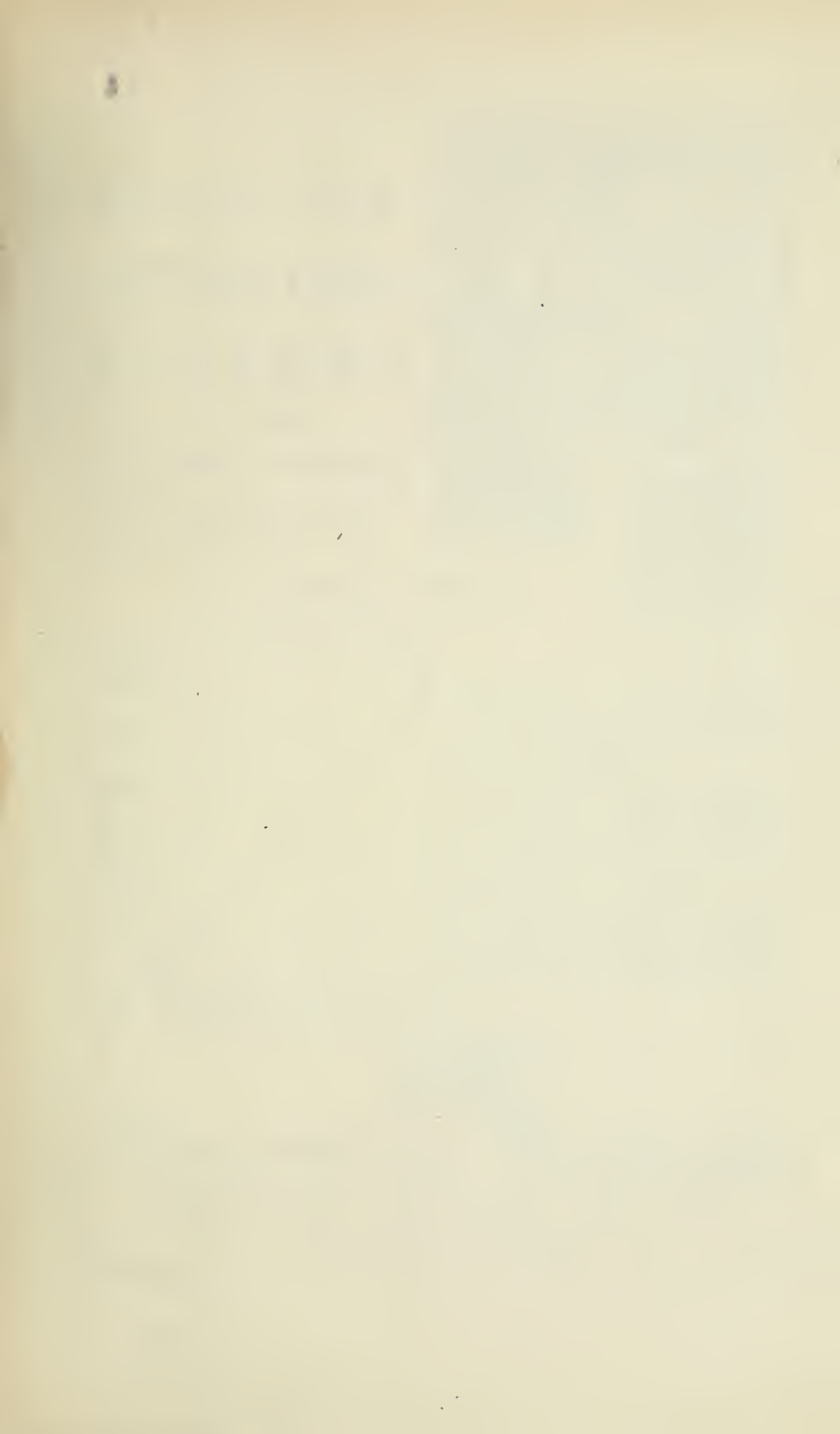
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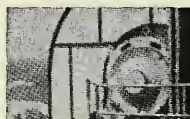
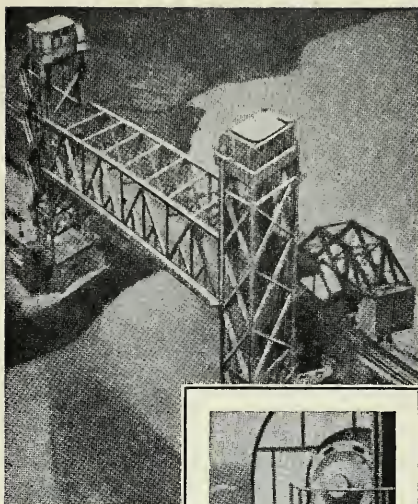


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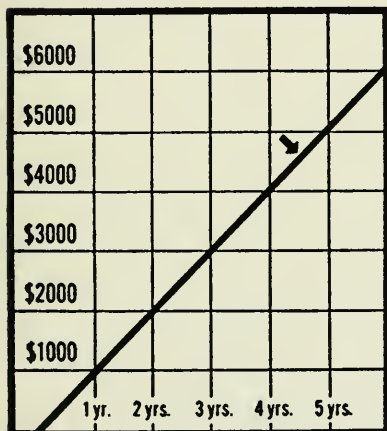
IN YOUR
POST-WAR PLANNING

ON VERTICAL-LIFT

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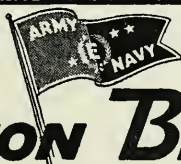
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